

# **Wetland and Water Quality Issues for Parks of the Northeastern US: A Scoping Report for the Northeast Coastal and Barrier Network**

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## Chapter 1 - Introduction

The purpose of this scoping report is to identify 305(b) and 303(d) listed waters, to provide statistics on wetlands areas and wetlands potentially impacted by impaired waters, and to describe past and current water quality monitoring programs within National Park Service (NPS) units for the eight (8) units within the Northeast Coastal and Barrier Network, as well as two (2) units on the immediate coast, but within the Northeast Temperate Network. The following ten (10) NPS units are included: Acadia National Park (ACAD), Assateague Island National Seashore (ASIS), Boston Harbor Islands National Park Area (BOHA), Cape Cod National Seashore (CACO), Colonial National Historical Park (COLO), Gateway National Recreation Area (GATE), George Washington Birthplace National Monument (GEWA), Fire Island National Seashore (FIIS), Sagamore Hill National Historic Site (SAHI), and Thomas Stone National Historic Site (TSHT).

Information on 305(b) and 303(d) waters are assessed by each state and a report submitted to the EPA every 2 years. We suggest that this document be updated in a timely fashion (every 3 to 4 years) in order to keep information current. This is especially important in the near future (2004-2006) as the EPA recommended in 2002 that states submit an Integrated Water Quality Monitoring and Assessment Report (EPA 2002b) to satisfy the requirements for both Section 305(b) and 303(d) of the Clean Water Act (EPA 2000).

Since each state differs slightly in their criteria for assessing and listing waters as impaired, Chapter 2 provides an overview of each state's (Maine, Massachusetts, Maryland, New Jersey, New York, and Virginia) water quality methodology. Chapters 3 to 12 provide information on each park's water quality, wetland area statistics, wetland concerns, and monitoring programs. Within each park specific Chapter, information is provided on water quality from 305(b) Reports and 303(d) Lists, a description of wetlands areas and statistics (estimated from GIS data), an approximation of the amount of wetlands adjacent to impaired (303d listed) waters as estimated from GIS data, and a description of past and present monitoring related to park wetlands and water quality programs (in addition to State programs related to 305(b) and 303(d) water quality monitoring).

Information on impaired waterbodies for Park units was summarized from EPA and state issued 305(b) Water Quality Reports and 303(d) Impaired Waterbodies Lists for waterbodies within or immediately adjacent to each park unit. The EPA websites were the primary source of 305(b) and 303(d) information. We found that individual state websites provided extensive information on water quality and monitoring programs, and all had 305(b) and 303(d) information in a downloadable format. There were several non-state environmental groups (i.e. Maryland Coastal Bays Program, South Shore Estuary Reserve) that also had great deal of information on monitoring programs. Sources of NPS information that were particularly helpful were Water Resource Management Plans, General Management Plans, Baseline Water Quality Data Inventory and Analysis Reports (available via the website

<http://www1.nature.nps.gov/water/horizon.htm>), and other NPS reports. NatureBib was researched for relevant documents, and some were found. These documents are not available via the internet; however, it did provide useful citation information for these documents. Information on outstanding natural resource waters was harder to obtain, and was not found for New York. Much of the information on monitoring programs was excerpted from Kopp et al. (2002), who reviewed existing estuarine nutrient monitoring programs for the Northeast Coastal and Barrier network in their July 2002 draft report.

NPS GIS layers were obtained from GIS specialists at NPS 7 of the park units (ACAD, ASIS, BOHA, CACO, COLO, FIIS, and GATE) and these detailed coverages were very useful in identifying and calculating wetland areas adjacent to impaired waterbodies. National Wetlands Inventory (NWI) data were used to identify wetland areas for GEWA and THST, and New York Natural Heritage data was used for SAHI. On average, the NPS GIS data tended to have more detail than the NWI coverages. GIS data available via the NPS GIS Data Clearinghouse website ([http://www.nps.gov/gis/data\\_info/clearinghouse.html](http://www.nps.gov/gis/data_info/clearinghouse.html)) was not very helpful, as these data (for the most part) were not as detailed as those obtained by contacting the park directly. The number of wetland hectares influenced by 303(d) waterbodies was estimated by identifying wetland polygons adjacent to impaired waterbodies from GIS coverages. Impaired waterbodies were first identified within each park unit and located on GIS maps. Vegetation GIS coverages were then used to identify wetland vegetation polygons adjacent to each impaired waterbody. These wetland polygons were then categorized as either non-forested or forested wetlands and a total for each wetland type was then calculated. In each park specific chapter, a table is provided that lists each impaired waterbody and the total area (in hectares) of non-forested and forested wetlands adjacent to these waters. As of this writing these calculated areas of wetlands influenced by 303(d) waters have not been verified by each park, however, since the majority of GIS coverages were obtained directly from park GIS specialists, we feel that these estimates are as accurate as the GIS data on which they are based. One thing that was generally lacking for all parks was detailed GIS data on streams (intermittent and otherwise).

### 305(b) Reports and 303(d) Lists: An Overview

An introduction to the Clean Water Act, the 305(b) Water Quality Reports, and 303(d) Impaired Waterbodies Lists is given to provide the reader with background information concerning the definition of attainment status for designated uses and associated water quality assessments of waterbodies. Since each state defines its own water quality standards, assessment methodology, and designated uses, a brief discussion on the state-specific water quality assessment methodology is provided for states where the ten NPS units are located. Tables are then presented containing summary information from 305(B) Water Quality Reports and 303(d) Impaired Waterbodies Lists for waterbodies within or immediately adjacent to each park unit. Information for the 305(b) and 303(d) summary tables was obtained from the Environmental Protection Agency (EPA) Waters website <http://www.epa.gov/waters/> which provides both Federal and State 305(b) Water Quality Reports and 303(d) Impaired Lists. For the majority of waterbodies the EPA Water Quality Inventory website (<http://www.epa.gov/waters/305b/index.html>) had the

most current and complete information for 305(b) assessment and attainment status. Information for 303(d) Impaired Waterbodies Lists was summarized from the EPA Total Maximum Daily Load (TMDL) Reports (<http://www.epa.gov/waters/tmdl/index.html>) and state issued 303(d) Impaired Waters Lists (from individual state websites). Occasionally, the 303(d) Impaired Waterbodies Lists from the state websites were more current or more complete than the information found on the EPA website, in those cases the most current information was used.

The Clean Water Act, adopted by Congress in 1972, requires that states, territories, and authorized tribes (hereafter referred to as “States”) develop water quality standards for the protection and restoration of waters within their jurisdictions. The two principal goals of the CWA are to: 1. restore and maintain the chemical, physical, and biological integrity of the Nation’s waters; and 2. where attainable, to achieve water quality that promotes protection and propagation of fish, shellfish, and wildlife, and provides for recreation in and on the water. States report (once every two years) to the EPA and Congress under a specific part of the CWA, known as Section 305(b), on whether these goals are being achieved (EPA 1999). This report is called the 305(b) Water Quality Report. The 305(b) Water Quality Report identifies impairments, if existing, for waters within each state. Waters listed in the 305(b) report are referred to as 305(b) listed waters and can be found on the EPA’s Water Quality Inventory Electronic 305(b) Report website (<http://www.epa.gov/waters/305b/index.html>). This list includes the attainment status (e.g. supporting, not supporting) for designated uses (e.g. aquatic life support, fish consumption, primary contact recreation) for specific waterbodies. There are several designated uses of water quality for which the states are required to monitor. Each designated use has a unique set of water quality criteria, set individually by each state that must be met for the designated use to be realized. In the 305(b) Water Quality Report, the state must identify the type of assessment (monitored or evaluated) that was used to make each designated support determination. Monitored assessments are based on data collected within the past 5 years. Evaluated assessments are based on qualitative information (if no monitoring data are available) or on monitoring data that are more than 5 years old (EPA 2000). If available, specific water quality, biological and physical data can be obtained from STORET (short for STORage and RETrieval): <http://www.epa.gov/STORET/index.html>.

Each waterbody has a water quality standard. A water quality standard consists of three elements: 1. the designated use(s) of a water body or segment of a waterbody; 2. the water quality criteria necessary to protect the use or uses of that particular waterbody; and 3. an antidegradation policy. Examples of designated uses are recreation and protection of aquatic life. Water quality criteria describe the quality of water that will support a designated use. Water quality criteria may be expressed either in numeric units or a narrative statement, and an antidegradation policy ensures that water quality improvements are conserved, maintained, and protected (EPA 1999). Water quality standards apply to surface waters, including wetlands. Surface waters include rivers, streams, lakes, oceans, estuaries, and wetlands; they do not include ground water. A single water quality standard need not be applied to the entire waterbody (e.g. the length of a stream); different water quality standards may be set on different segments of the

same waterbody (EPA 1999). The EPA reviews new or revised water quality standards that States adopt to determine whether the standards meet CWA requirements. EPA also reviews that standards of each State to ensure that they do not interfere with attainment of standards in waters shared with another State or waters located in another State downstream. If EPA disapproves a State's water quality standards, or determines that a new or revised water quality standard is necessary to meet the requirements of the CWA, EPA may issue water quality standards to which the State is bound (EPA 1999).

The EPA water quality standards program categorizes water uses in two ways: designated uses and existing uses. A designated use is the legally applicable use specified in a water quality standard for a watershed, waterbody, or segment of a waterbody. A designated use is a use that, presently, may or may not be met or attained. All pollution control activities are designed to attain the designated uses. Designated uses may be changed upon finding that the use cannot be attained. An existing use is the use that has been achieved or attained for a waterbody and that use and water quality supporting that use must be protected and maintained (EPA 1999). States are responsible for establishing designated uses of a waterbody. Categories of designated uses vary by State and each State develops its own use classification system based on the generic uses cited in the CWA (EPA 1999).

In setting their water quality standards, States assign one or more designated uses to each waterbody. Under Section 305(b) of the CWA, assessment of an individual waterbody (e.g. stream segment or lake) means analyzing biological, habitat, physical/chemical, and/or toxicity data and other information to determine: 1. the degree of designated use support or attainment status of the waterbody (e.g. fully supporting, partially supporting, not supporting, Category 1 through 5); 2. if designated uses are impaired, the causes (pollutants or other stressors) and sources of the problem; 3. degree of achievement of biological integrity using State biological criteria or other measures; and 4. descriptive information such as the type and quality of data used in the assessment (EPA 1997). Since each state sets its own water quality standards, the attainment status for designated uses is slightly different for each state. The EPA has suggested that each State use the attainment categories (Categories 1 through 5, see below) put forth in the 2002 Integrated Report Guidance (EPA 2002a) however, since most States have not yet submitted their water quality reports in the integrated format, attainment status and categories still vary from state to state.

In addition to the 305(b) Water Quality Report, The Clean Water Act, Section 303(d), requires that states develop an Impaired Waterbodies List for waterbodies that do not meet the water quality standards that the states have set. This list comprises two types of waters: first, those in which water quality standards cannot be met because of the presence of toxic pollutants; second, those in which the following uses cannot be maintained or achieved. These uses include public water supplies, agricultural and industrial uses, the protection and propagation of a balanced population of shellfish, fish and wildlife, and recreational activities in and on the water (EPA 1999). States must establish priority ranking for these waters and develop Total Maximum Daily Load (TMDL) programs for these waters. A TMDL specifies the maximum amount of a

pollutant that a waterbody can receive and still meet water quality standards, and allocates pollutant loadings among point and non-point sources. The EPA must approve the TMDL (EPA 2002a). While TMDLs have been required by the Clean Water Act since 1972, not many states, territories, or authorized tribes have not developed them until recently, a result of legal action against the EPA by citizens groups seeking the listing of waters and development of TMDLs. States, territories, or authorized tribes are required to submit their list of 303(d) waters in every even numbered year (referred to as the 2-year listing cycle). The 303(d) list is referred to as the 303(d) Impaired Waterbodies List and must be based on documented methodology that includes an evaluation of existing and readily available data. Waterbodies that have been identified as impaired and have existing TMDL or scheduled development for TMDL, are then added to the 303(d) Impaired Waters List for that state. Waterbodies continue to be included on subsequent Impaired Waterbodies Lists until TMDLs are completed, applicable criteria are met, or the original basis for the listing is shown to be flawed.

Prior to 2002, data collection and interpretation efforts under the Clean Water Act were not always coordinated. The EPA is now recommending that states submit an Integrated Water Quality Monitoring and Assessment Report (EPA 2002b) to satisfy the requirements for both Section 305(b) and 303(d) of the Clean Water Act (EPA 2000). The Integrated Report will combine the non-regulatory requirements of the 305(b) Water Quality Report with the regulation driven (mandated TMDL development) 303(d) Impaired Waterbodies List. The EPA has established several basic categories (categories 1 through 5) for the Integrated Report. Some states (e.g. Virginia) have added additional categories for greater specificity. For the majority of states discussed in this report, the EPA guidance for integrating the 305(b) and 303(d) information was issued too late to fully implement for the 2002 report and listing cycle. Future reports (after 2002) will fully integrate the 305(b) and 303(d) reports into one report (EPA 2002b).

*305(b) EPA Designated Uses (EPA 2000):*

*Aquatic Life Support:* The water body provides for suitable habitat for protection and propagation of desirable fish, shellfish, and other aquatic organisms.

*Drinking Water Supply:* The water body can supply safe drinking water with conventional treatment.

*Fish Consumption:* The water body supports fish free from contamination that could pose a significant human health risk to consumers.

*Shellfish Harvesting:* The water body supports a population of shellfish free from toxicants and pathogens that could pose a significant human health risk to consumers.

*Primary Contact Recreation – Swimming:* People can swim in the water body without risk of adverse human health effects (such as catching waterborne diseases from raw sewage contamination).

*Secondary Contact Recreation:* People can perform activities on the water (such as boating) without risk of adverse human health effects from incidental ingestion or contact with the water.

*Agriculture:* The water quality is suitable for irrigating fields or watering livestock.

Many states designate their waters for additional uses such as:

*Ground Water Recharge:* The surface water body plays a significant role in replenishing ground water; surface water supply and quality are adequate to protect existing or potential uses of ground water.

*Wildlife Habitat:* Water quality supports the water body's role in providing habitat and resources for land-based wildlife as well as aquatic life.

*Culture:* Water quality supports the water body's role in tribal culture and preserves the water body's religious, ceremonial, or subsistence significance.

*EPA Water Quality Attainment Categories from the Integrated Report (EPA 2002a)*

*Category 1. Attaining the water quality standard and no use is threatened.* Assessment Units should be listed in this category if there are data and information that meet the requirements of the state's or territory's assessment and listing methodology and support a determination that the water quality standard is attained and no use is threatened. States and territories should consider scheduling these Assessment Units for future monitoring to determine if the water quality standard continues to be attained.

*Category 2. Attaining some of the designated uses; no use is threatened; and insufficient or no data and information is available to determine if the remaining uses are attained or threatened.* Assessment Units should be listed in this category if there are data and information which meet the requirements of the state's or territory's assessment and listing methodology to support a determination that some, but not all, uses are attained and none are threatened. Attainment status of the remaining uses is unknown because there is insufficient or no data or information.

Monitoring should be scheduled for these Assessment Units to determine if the uses previously found to be in attainment remain in attainment, and to determine the attainment status of those uses for which data and information were previously insufficient to make a determination.

*Category 3. Insufficient or no data and information to determine if any designated use is attained.* Assessment Units should be listed in this category where the data or information to support an attainment determination for any use are not available, consistent with the requirements of the state's or territory's assessment and listing methodology. To assess the attainment status of these Assessment Units, the state or territory should obtain supplementary data and information, or schedule monitoring as needed.

*Category 4. Impaired or threatened for one or more designated uses but does not require the development of a TMDL.*

*Category 4A. TMDL has been completed.* Assessment Units should be listed in this subcategory once all TMDL(s) have been developed and approved by EPA that, when implemented, are expected to result in full attainment of the standard. Where more than one pollutant is associated with the impairment of an Assessment Unit, the Assessment Unit will remain in Category 5 until all TMDLs

for each pollutant have been completed and approved by EPA. Monitoring should be scheduled for these Assessment Units to verify that the water quality standard is met when the water quality management actions needed to achieve all TMDLs are implemented.

*Category 4B. Other pollution control requirements are reasonably expected to result in the attainment of water quality standard in the future.* Consistent with the regulation under 130.7(b)(i), (ii), and (iii), Assessment Units should be listed in this subcategory where other pollution control requirements are stringent enough to implement any water quality standard (WQS) applicable to such waters. EPA expects that these requirements must be specifically applicable to the particular water quality problem. Monitoring should be scheduled for the Assessment Units to verify that the water quality standard is attained as expected.

*Category 4C. Impairment is not caused by a pollutant.* Assessment Units should be listed in this subcategory if the impairment is not caused by a pollutant. States and territories should consider scheduling these Assessment Units for monitoring to confirm that there continues to be no pollutant-caused impairment and to support water quality management actions necessary to address the cause(s) of the impairment.

*Category 5. The water quality standard is not attained.* The Assessment Unit is impaired or threatened for one or more designated uses by a pollutant(s), and requires a TMDL. This category constitutes the Section 303(d) list of waters impaired or threatened by a pollutant(s) for which one or more TMDL(s) are needed. An Assessment Unit should be listed in this category if it is determined, in accordance with the state's or territory's assessment and listing methodology, that a pollutant has caused, is suspected of causing, or is projected to cause an impairment. Where more than one pollutant is associated with the impairment of a single Assessment Unit, the Assessment Unit will remain in Category 5 until TMDLs for all pollutants have been completed and approved by EPA.

In previous years, when a waterbody was removed from the 303(d) Impaired Waterbodies List (e.g. after a TMDL was approved) it was no longer tracked. Under the new integrated methodology, a waterbody which is removed from Category 5 remains on the integrated List in one of the other four categories.

Prior to the 2002 Integrated Report, the follow attainment status categories were used to describe water quality attainment. As previously mentioned, for some states the EPA guidance (2002b) for integrating the 305(b) and 303(d) information was issued too late to fully implement for the 2002 report. As a result, these older assessment categories (EPA 1997) were still in use by some states when this document written.

*Fully Supporting:* No impairment of designated use as indicated by all data types.

*Fully Supporting but Threatened:* No impairment of designated use as indicated by all data types; one or more categories indicate an apparent decline in ecological quality over time or potential water quality problems requiring additional data or verification, or other information suggests a threatened determination.

*Partially Supporting\**: Impairment indicated for designated use by one or more data types and no impairment indicated by others.

*Not Supporting\**: Impairment indicated for designated use by all data types.

\* A determination of *partially supporting* or *not supporting* could be made based on the nature and rigor of the data and site-specific conditions in the results of the data types.

#### *Other EPA Definitions*

*Assessment Unit*: A waterbody whose attainment status is reported in the Integrated Report. An assessment unit must be named and located based on the National Hydrography Dataset and identified by their Hydrologic Unit Code (HUC) (Table 1-1).

*Water quality standard*: A water quality standard defines the water quality goals of an assessment unit by designating the use or uses to be made of the assessment unit and by setting criteria, both numeric and narrative, necessary to protect the designated use(s).

*Water quality is attained*: The water quality standard is attained when all designated uses and associated criteria are met as determined in accordance with a state's or territories assessment and listing methodology.

*Water quality standard is threatened*: The water quality standard is being attained, but no attainment is predicted, in accordance with the state's or territory's assessment and listing methodology, by the time the next Integrated Report is due.

*Water quality standard is not attained (impaired)*: The water quality standard is not attained in accordance with a state's or territory's assessment and listing methodology.

#### Outstanding Resource Waters

The Outstanding National Resource Waters (ONRW or Tier 3 waters), provision in the Clean Water Act provides that "where high quality waters constitute an outstanding National resource, such as waters of National Parks, State parks and wildlife refuges, and waters of exceptional recreational or ecological significance, that water quality shall be maintained and protected." (EPA 1994). ONRWs are waters that are ecologically important, unique, or sensitive (such as swamps or hot springs), which the commonly applied use classifications and supporting criteria do not always serve to protect (EPA 1999). States may allow some limited activities which result in temporary and short-term changes in water quality, but such changes in water quality should not impact existing uses or alter the essential character or special use that makes the water an ONRW (EPA 1994). While ONRWs are often regarded as having the highest water quality, this is not a requirement. Waters that are of exceptional recreational and/or ecological significance need not have particularly high water quality to be provided status as an ONRW. ONRW designation of a water body provides the maximum protection to water quality under the Clean Water Act and insures that no permanent degradation of water quality will occur.

Table 11-1 Hydrologic Unit Codes (HUC) for watersheds within the boundaries of NPS units in the Northeast Coastal and Barrier Network, Acadia NP, and Boston Harbor Islands National Park Area. HUC codes can be found at the EPA Surf Your Watershed website: <http://cfpub.epa.gov/surf/locate/map2.cfm>.

<b>NPS Unit</b>	<b>State</b>	<b>Watershed</b>	<b>HUC</b>
ACAD	Maine	Maine Coastal	01050002
ASIS	Maryland	Chincoteague	02060010
ASIS	Virginia	Chincoteague	02060010
BOHA	Massachusetts	Charles	01090001
CACO	Massachusetts	Cape Cod	01090002
COLO	Virginia	Lower James	02080206
COLO	Virginia	York	02080107
FIIS	New York	Southern Long Island	02030202
GATE	New York	Southern Long Island	02030202
GATE	New Jersey	Sandy Hook-Staten Island	02030104
GEWA	Maryland	Lower Potomac	02070011
GEWA	Virginia	Lower Potomac	02070011
SAHI	New York	Northern Long Island	02030201
THST	Maryland	Lower Potomac	02070011

#### Definition of Terms used in Tables

Summary information for 305(b) and 303(d) information for the ten (10) park units are provided in tables associated with each park unit. Occasionally, a waterbody is listed multiple times in a table. This occurs either because multiple segments of the waterbody were individually listed giving more specific information or the waterbody identification numbers (ID) were not similar between the EPA 305(b) or EPA 303(d) identification numbers and the state assigned waterbody ID. Since it was unclear whether the information was for the same waterbody, all listings are presented. Each of the summary tables provides the following information:

*Waterbody:* the descriptive name of the waterbody, and occasionally a description of the specific reach or segment of the waterbody (particularly if the waterbody was large as in a major river).

*Listing Cycle:* Provides the date(s) of the most current information for the 305(b) attainment of designated uses and/or 303(d) impaired water quality information. The majority of 303(b) information on attainment status was from the EPA,

- whereas the 303(d) information was the most current and complete of either the EPA TMDL Reports or the individual state 303(d) Impaired Waterbodies List.
- 305(b) Assessment Unit ID:* The identification number used by the EPA to identify a specific waterbody, reach or segment in the 305(b) Water Quality Inventory Reports. If 305(b) attainment information could not be located for a website waterbody is indicated as “*Not listed*”. This was the case for the states of New York and New Jersey since they have not yet submitted electronic 305(b) information to the EPA (and therefore it is not available on the EPA’s water Quality and Inventory website) and no 305(b) specific waterbody attainment status could be found in their Water Quality Reports.
- 303(d) List ID or State segment ID:* The identification number used by the EPA and the state to identify a specific waterbody, reach, or segment in the 303(d) Impaired Waterbodies List. Usually, the 303(d) List ID from the EPA was the same as the state’s listing ID in the state issued 303(d) Impaired Waterbodies List. However, there were instances where the state had more current or complete information for a specific waterbody’s reach or segment and in that case the state’s or segment’s identification number is given and is indicated by the words (*State ID, segment ID*) under the identification number.
- Integrated List Category and/or Class:* Some states (e.g. Maine, Massachusetts, New Jersey, and Virginia) have integrated the 2002 305(b) and 303(d) reports into the Integrated Water Quality Monitoring and Assessment Report. Information on designated classes of waterbodies for some states (e.g. Maine, Massachusetts, New Jersey, and New York), if available, is listed.
- Water Quality Attainment Status for State Designated Uses & Impairment:* This column provides a summary of 305(b) and 303(d) information. The *Water Quality Attainment Status* [305(b) information] determines whether or not the water quality for a specific waterbody was supporting its 305(b) designated uses. Attainment status is categorized as Fully Supporting, Partially Supporting, Not Assessed, Precluded, or Not Supporting. *Designated Uses* are categorized as aquatic life support, fish consumption, primary contact recreation, secondary contact recreation, etc. Information for attainment status for all designated uses was not available for all waterbodies, however, the most complete information is given. In some cases, particularly for waterbodies within New York and New Jersey, the attainment status for designated uses could not be found, presumably because these states have not yet submitted electronic data to the EPA and therefore it was not available on the EPA’s water Quality and Inventory website or within the state’s 305(b) Water Quality Report.
- Water Impairment and Source:* This is 303(d) Information. Water Impairment lists the impairment of water quality responsible for the attainment status previously given. Source indicates the pollutant source (if known) for the listed water impairment.

In some cases (e.g. New York, Virginia) the attainment status was given in the 303(d) Impaired Waterbodies List. For the state of Maine (ACAD National Park), there were little data available on the EPA Waters website [305(b) and 303(d)] in terms of attainment status, impairment, and sources. The majority of information was compiled

from the 2002 Integrated Report (ME-DEP 2002). While this report included many waterbodies within the boundaries of ACAD, specific information of attainment of designated uses, impairments, and sources were not found. Therefore for these waterbodies, the integrated list category information is given instead.

## Chapter 2 - State Water Quality Assessment Standards

### Maine Water Quality Assessment

The NPS unit within the state of Maine is Acadia National Park. The Maine Department of Environmental Protection (ME-DEP) has compiled the 2002 Integrated Water Quality Monitoring and Assessment Report that integrates 305(b) and 303(d) information for the 2002 listing cycle (ME-DEP 2002a). Information found in this report is more complete than that found on the EPA WATERS website (<http://www.epa.gov/waters/>). The 2002 integrated report (ME-DEP 2002a) established five new assessment categories, and as such, information on attainment assessment in the integrated report may not be comparable to previous 305(b) and 303(d) lists. Specifically, impaired waters are now subdivided into Categories 4 and 5. Maine has further subdivided the integrated list Categories 4-B and 5. Information on these categories is given below and more detail can be found in ME-DEP (2002a).

*Category 4B-1:* Includes waterbodies where enforceable controls have reasonable expectation of attaining standards, but where no new data are available to determine that attainment has been achieved.

*Category 4B-2:* Includes waterbodies with combined sewer overflows (CSO) and with current CSO Master Plans which include assurances that water quality standards will be attained.

*Category 5-A:* Includes waterbodies where the impairment is caused by pollutants (other than those listed in 5-B through 5-D) and a TMDL is required.

*Category 5-B:* Includes waterbodies where the impairment is caused solely by bacteria contamination.

*Category 5-C:* Includes waterbodies where the impairment is caused by atmospheric deposition (all freshwaters are listed as 5-C for fish consumption advisory due to mercury contamination and are also listed under one of the other categories).

*Category 5-D:* Includes waterbodies that are impaired by a “legacy” pollutant such as PCBs, DDT, or other substances already banned from production or use and are impaired by contaminated sediments where there is no additional extrinsic loading. All coastal waters are listed as 5-D for fish consumption advisory for lobster tomalley.

The Maine DEP uses a five year rotation schedule for monitoring rivers and streams (ME-DEP 2002a). In addition, the state regularly conducts river-scale water quality monitoring to develop and update water quality models. The majority of lake monitoring is conducted by individuals, regional entities, or local organizations through the Volunteer Lake Monitoring Program (VLMP) (ME-DEP 2002a). Lakes that are attaining all or most of their standards are visited once every 5 years during August (August 10<sup>th</sup> through August 15<sup>th</sup>). Lakes that are in non-attainment and in the process of TMDL development are generally monitored by the State or cooperators more intensely such as twice a month during the ice-free season. Lakes that have completed TMDLs (Category

4A) or that are Category 3 Watch List are often monitored once a month during the summer season by the State or cooperators. Other lakes in Category 3 are monitored less frequently because the risk of non-attainment has decreased such as through the removal of discharge. Marine waters and estuaries are scheduled to be monitored on a three year rotation schedule. However, the Department of Marine Resources (DMR) provides the majority of monitoring on Category 3 waters and a schedule for DMR monitoring is not available at this time (ME-DEP 2002a).

State designated uses and attainment status for Maine waterbodies are described below (Davies et al. 1999; ME-DEP 2002a; ME-DEP 2002b). The state has designated one standard (GPA) for the classification of freshwater great ponds and natural lakes less than 10 acres in size. Class GPA waters are described by their trophic state (based on chlorophyll-*a*, Secchi disk transparency, total phosphorus content and other appropriate criteria). Riverine waters are classified as AA, A, B, or C. Estuarine and marine waters are designated into one of 3 classes (SA, SB, and SC). Each of these classes is managed for designated uses and has dissolved oxygen, bacteria, and aquatic life standards.

*Class GPA waters (freshwater):* Great ponds and lakes less than 10 acres in size. These waters are suitable for the designated uses of drinking water after treatment, recreation in and on, fishing, industrial processes and cooling water supply, hydroelectric power generation and navigation, and as a habitat for fish and other aquatic life. There may be no direct discharge of pollutants, and the habitat must be characterized as natural.

*Class AA waters (riverine):* High Quality Water. This is the highest classification and shall be applied to waters which are outstanding natural resources and which should be preserved because of their ecological, social, scenic or recreational importance. These waters are classified for drinking water supply, recreation in and on, fishing, navigation and a natural and free flowing habitat for fish and other aquatic life. No dischargers or impoundments are permitted.

*Class A waters (riverine):* High Quality Water with limited human interference. These waters are classified for drinking water supply, recreation in and on, fishing, industrial process and cooling water supply, hydroelectric power generation, navigation and a natural habitat for fish and other aquatic life. Discharges limited to noncontact process water or highly treated wastewater of quality equal to or better than receiving water. Impoundments allowed.

*Class B waters (riverine):* Good water Quality. These waters are classified for drinking water supply, recreation in and on, fishing, industrial process and cooling water supply, hydroelectric power generation, navigation and an unimpaired habitat for fish and other aquatic life. Discharge of well treated effluent with ample dilution permitted.

*Class C waters (riverine):* Lowest Water Quality. These waters are classified for drinking water supply, recreation in and on, fishing, industrial process and cooling water supply, hydroelectric power generation, navigation and a habitat for fish and other aquatic life. Maintains the interim goals of the Federal Water Quality Act (fishables/swimmables). Discharge of well treated effluent permitted.

*Impoundments:* Riverine impoundments classified as Great Ponds and managed for hydropower generation.

*Class SA waters (marine and estuarine):* These waters are managed for high water quality with limited human interference allowed. No direct discharge of pollutants is allowed into Class SA waters. These waters are classified as outstanding natural resources which should be preserved because of their ecological, social, scenic, economic or recreational importance.

*Class SB waters (marine and estuarine):* These waters are general purpose waters and are managed to attain good water quality. Well-treated discharges of pollutants that have ample dilution are allowed.

*Class SC waters (marine and estuarine):* These waters are managed for the lowest water quality but must be fishable and swimmable and maintain the structure and function of the biological community. Well-treated discharges of pollutants are allowed.

Class GPA designated uses:

*Aquatic Life Support:*

*Attainment:* Lakes exhibiting stable or improving trends in trophic state.

*Non-attainment:* Lakes that experience extreme water level fluctuations or severe turbidity.

*Fish Consumption:*

*Attainment:* No fish consumption advisories in effect.

*Non-attainment:* “Restricted Consumption” fish advisory or ban in effect during the reporting period for the general population or a subpopulation (e.g. pregnant women, children). All Maine lakes are considered as Partially Supporting fish consumption due to mercury contamination.

*Recreation In/On (swimming):*

*Attainment:* Lakes that do not exhibit regular, nuisance algal blooms during the summer (high use) period.

*Non-attainment:* Lakes in which swimming is chronically (more than 5 of the past 10 years) impaired during part of the recreation season due to culturally induced nuisance algal blooms.

*Drinking Water Supply:*

*Attainment:* Lakes for which data suggest that the water is suitable for drinking after reasonable treatment.

*Non-attainment:* Lakes designated as a water supply, for which data suggest that the water is no longer suitable for drinking with reasonable treatment.

Class SA, SB, SC designated uses:

*Shellfish Propagation and Harvest of Shellfish:* Shellfish areas are classified as approved for harvesting (supporting), conditional or restricted under a designated set of environmental conditions (partially supporting), or prohibited (not supporting).

*Recreation in and on the Water:* There is limited monitoring of Maine beaches.

*Fishing:* A human health consumption advisory has existed since 1992 coast wide against the consumption of lobster tomalley. This advisory was expanded to include

bluefish and striped bass in 1996. The entire Maine coast is in partial support of its designated use due to these consumption advisories.

*Marine Life Support:* Information on dissolved oxygen and eutrophication are used to determine this assessment. Generally, data show oxygen levels along the Maine coast are adequate for the protection of aquatic life. Although some estuaries contain oxygen levels that do not meet the dissolved oxygen standards of their assigned classification, it was concluded that many of the levels measured were a result of natural processes.

*Navigation, Hydropower, Industrial Supply, and Aquaculture:* Aside from general provisions, there are no criteria for assessing these designated uses.

Maine water quality attainment definitions (ME-DEP 1996):

*Fully supporting:* Water quality meets all designated use criteria.

*Threatened:* Water quality supports beneficial uses now but may not in the future unless action is taken.

*Partially supporting:* Water quality fails to meet designated use criteria at times.

*Not Supporting:* Water quality frequently fails to meet designated use criteria.

*Not Attainable:* The state has performed a use-attainability analysis and demonstrated that use support is not attainable due to biological, chemical, physical, or economic/social conditions.

### Maryland Water Quality Assessment

NPS units within the state of Maryland are portions of Assateague Island National Seashore, portions of George Washington Birthplace National Monument (Lower Potomac River), and Thomas Stone National Historic Site.

In 2002, The Maryland Department of the Environment (MDE) submitted a draft integrated list of impaired waters (MDE 2002) and has published a 2000 305(b) Report (MD-DNR 2000). The 2002 List integrates both 305(b) and 303(d) information. The EPA WATERS website has both 305(b) and 303(d) information for Maryland, however much of this information is from the 1998 listing cycle and therefore the 2002 draft list of impaired waters (MDE 2002) contains the most current information. The 2002 List (MDE 2002) is considered a transition list between prior lists [e.g. 1996 and 1998, the last time Maryland published a 303(d) list] since the EPA's guidance for integrating 305(b) and 303(d) information came late in the development process for Maryland's 2002 303(d) list. Future lists will be more integrated with Maryland's 305(b) report. The Maryland Department of Natural Resources (MD-DNR) and the Maryland Department of the Environment are responsible for collecting and compiling 303(d) data. MD-DNR compiles the 305(b) report which summarizes water quality monitoring information.

A waterbody is considered impaired when it does not attain the designated uses assigned to it by Maryland law. Attainment is determined by field measured or projected values of various water quality parameters. Use support assessment was based on either site-specific data monitored at least monthly (monitored) or on older (more than 5-years)

information about uses data (evaluated). Waterbodies and reaches with no recent and readily accessible data are listed as “unknown” (MD-DNR 2000). Maryland surveys surface waterbodies on a 5-year rotating basis, with about one fifth of the State intensively sampled for water quality monitoring, pollutant source assessment, and collection of other parameters to support TMDL modeling every year. Therefore complete coverage of the State will occur in a 5-year cycle. Maryland’s water monitoring program can be categorized into three general categories (MD-DNR 2000):

*Long-term ambient monitoring programs:* fixed station, long-term (initiated in the 1970’s) programs sampling on a regular basis (water quality, benthic macroinvertebrate, fish tissue, phytoplankton, zooplankton, and shellfish monitoring)

*Short-term intensive monitoring:* special studies in which a number of samples may be collected in a small section of a particular waterbody or with a high sampling frequency in an effort to determine the cause of a water quality problem or for modeling studies.

*Estuarine monitoring:* a suite of monitoring programs (water and sediment chemistry, plankton and benthic macroinvertebrate sampling and sediment- nutrient flux sampling, nutrient limitation) initiated as part of the State’s Chesapeake Bay Program in 1984 or the planned Coastal Bays Monitoring Program.

Maryland’s basic use designation (defined below) is referred to as Use I and is equivalent to the national goal “which provides for the protection and propagation of fish, shellfish, and wildlife and provides for recreation in and on the water”. Waters which support higher or more specific uses (shellfish harvesting, trout waters, and drinking water) are classified as Use II, III, or IV, and potable waters are designated by a “P” after the use designation.

*Use I:* Water contact recreation, fishing, propagation of fish, other aquatic life, and wildlife, and agricultural and industrial water supply and *Use I-P:* drinking water supply

*Use II:* Shellfish harvesting. Areas are classified as either:

*Approved:* Shellfishing is allowed

*Restricted:* Area is closed to shellfishing. Restricted areas are also established around municipal treatment plant outfalls and marinas.

*Conditionally Approved:* Area meets bacterial requirements at most times, but is closed to harvesting for a short period following one or more inches of rain within a 24-hour period.

*Use III:* Natural trout waters (naturally reproducing trout can live and propagate) and *Use III-P:* drinking water supply

*Use IV:* Recreational trout waters and *Use IV-P:* drinking water

Specific water quality criteria for each of the above designated uses can be found in Maryland’s 2000 305(b) Report (MD-DNR 2000).

Use support is defined as the following (MD-DNR 2000):

*Fully Supporting:* Water quality conditions are “good” and water quality meets designated use criteria. For overall use support, (where there is more than one use) all designated uses are fully supported.

*Threatened:* Water quality conditions are “good” and water quality supports designated uses now but may not in the future unless remedial action is taken. For overall use support, (where there is more than one use) one or more beneficial uses are threatened and the remaining uses are fully supported.

*Partially Supporting:* Water quality conditions are “fair” and, at times, water quality fails to meet designated use criteria or fails to a limited extent. For overall use support, (where there is more than one use) one or more designated uses are partially supported; remaining uses are fully supported or threatened.

*Not Supporting:* Water quality conditions are “poor” (impaired) and water quality frequently fails or by a large extent, fails to meet designated use criteria. For overall use support, (where there is more than one use) one or more designated uses are not supported. These waterbodies are considered *impaired*.

### Massachusetts Water Quality Assessment

NPS units within the state of Massachusetts and included in this report are Boston Harbor Islands National Park Area and Cape Cod National Seashore.

In 2002, the Massachusetts Department of Environmental Protection (MA-DEP) compiled a report that integrates 305(b) and 303(d) information in the Massachusetts Year 2002 Integrated List of Waters (Commonwealth of Massachusetts 2002). Water quality reports for Boston Harbor (MA-DEP 2002a) and Cape Cod watershed (MA-DEP 2002b) are also available. These reports are more complete than what is available on the EPA WATERS website. The integrated list report (Commonwealth of Massachusetts 2002), lists waters by the individual categories as outlined by the EPA (2002b). However, Massachusetts has not classified any waters as Category 1 “*waters attaining all designated uses*” due to a statewide health advisory issued by the Massachusetts Public Health Department (MA-DPH 2001) pertaining to the consumption of finfish because of suspected mercury contamination. This advisory precludes any waters from being in full support of the fish consumption use, including those that are currently “Not Assessed.”. Additionally, Massachusetts has not designated any waters as Category 4B “*waters expected to attain all designated uses in the near future*” because the state believes the guidance was not clear with respect to the time-frame in which the uses would need to be attained, but has generally been interpreted as meaning by the time the next integrated list is produced (Commonwealth of Massachusetts 2002).

Massachusetts classifies waters according to the Surface Water Quality Standards (SWQS) and assigns all inland, coastal, and marine waters to classes according to the intended use of those waters. These Classes are (MA-DEP 1996):

*Class A:* Waters designated as a source of public water supply. To the extent compatible with its use they shall be an excellent habitat for fish, other aquatic life and

wildlife, and suitable for primary and secondary contact recreation. These waters shall have excellent aesthetic value. These waters are designated for protection as Outstanding Resource Waters (ORWs).

*Class B:* These waters are designated as habitat for fish, other aquatic life and wildlife, and suitable for primary and secondary contact recreation. Where designated they shall be suitable as a source of water supply with appropriate treatment. They shall be suitable for irrigation and other agricultural uses and for compatible industrial cooling and process uses. These waters shall have consistently good aesthetic value. These waters can be classified as Cold Water Fisheries or specifically designated as Warm Water Fisheries.

*Class SA:* These waters are designated as an excellent habitat for fish, other aquatic life and wildlife and for primary and secondary recreation. In approved areas they shall be suitable for shellfish harvesting without depuration (Open Shellfishing Areas). These waters shall have excellent aesthetic value.

*Class SB:* These waters are designated as habitat for fish, other aquatic life and wildlife and for primary and secondary recreation. In approved areas they shall be suitable for shellfish harvesting with depuration (Restricted Shellfishing Areas). These waters shall have consistently good aesthetic value.

Specific details on state designated uses and water quality standards that must be met to sustain those designated uses can be found in the Water Quality Assessment Reports (e.g. MA-DEP 2002a, 2002b). Designated uses include aquatic life, fish consumption, drinking water, primary contact recreation, secondary contact recreation, aesthetics, and agricultural and industrial. Each designated use is assessed as support, partial support, or non support. The term “*threatened*” is used when the use is fully supported but may not support the use within 2 years because of adverse pollution trends or anticipated sources of pollution. “*Not assessed*” indicates that there too little current data exist or there no reliable data are available. Not all waters are assessed, as many small and/or unnamed lakes, rivers, and estuaries are currently not assessed, and as such their status of designated uses has never been reported to the EPA in the Commonwealth’s 305(b) Report.

The designation of Outstanding Resource Waters (ORW) is applied to waters with exceptional socio-economical, recreational, ecological and/or aesthetic value (Rojko et al. 1995). These waters have more stringent requirements than other waters because the existing use is so exceptional that the perceived risk of harm is such that no lowering of the water quality is permissible (MA-DEP 2002b). These waters include all designated Class A Public Water Supplies, certified vernal pools, and may include surface waters found in Areas of Critical Concern, National Parks, State Parks, and State Forests and those protected by special legislation (MA-DEP 1993, MA-DEP 2002b)

### New Jersey Water Quality Assessment

The NPS unit within the state of New Jersey is Gateway National Recreation Area, Sandy Hook Unit.

In 2002 the New Jersey Department of Environmental Protection (NJ-DEP) submitted an Integrated Water Quality Monitoring and Assessment Methods Report (NJ 2002a) and a 2002 Integrated List of Waterbodies (NJ 2002b) under the guidance of EPA for integrating the 305(b) Water Quality Report with the 303(d) Impaired Waterbodies List. A detailed explanation for the assessment of water quality criteria for each parameter for New Jersey is given in the Integrated Water Quality Monitoring and Assessment Methods Report (NJ 2002a). Briefly discussed here are the basic data requirements for sample frequency and collection for some parameters. For conventional parameters (dissolved oxygen, pH, total phosphorus, total suspended solids, total dissolved solids, sulfate, temperature, chloride, and nitrate) the minimum sampling frequency is at least 10 samples, collected quarterly, over 2 years (recommended). If this requirement not met, then the assessment methodology is termed “estimated” (as opposed to “monitored”) and at least 4 samples are required. The data must be the most recent 5 years of available data. For metals the minimum sampling frequency is at least 4 samples collected with 5 years and the data must be the most recent 5 years of available data.

Attainment of Surface Water Quality Standards (SWQS) for conventional parameters (dissolved oxygen, pH, total phosphorus, total suspended solids, total dissolved solids, sulfate, temperature, chloride, and nitrate) are based on the criteria listed below. Attainment criteria for other parameters (e.g. toxics, organics, metals) and designated uses (e.g. aquatic life designated use, recreational use, shellfishing) are not detailed herein since they are specific to each waterbody type (e.g. rivers, lakes, estuaries). Specific criteria can be found in the Integrated Water Quality Monitoring and Assessment Methods Report (NJ 2002a).

The New Jersey Department of Environmental Protection uses ten classifications for identifying water quality of the states’ waters (NJ-DEP 2002):

*FW1*: Freshwaters that are preserved for posterity and are not subject to man-made wastewater discharges. Designated uses are: primary and secondary contact recreation; maintenance, migration, and propagation of the natural and established biota; and any other reasonable uses. These waters are designated as Outstanding National Resource Waters.

*FW2*: Freshwaters. Designated uses are: maintenance, migration, and propagation of the natural and established biota; primary and secondary contact recreation; industrial and agricultural water supply; public potable water supply after conventional filtration treatment and disinfection; and any other reasonable uses.

*FW2-TP*: FW2 for trout production.

*FW2-TM*: FW2 for trout maintenance.

*FW2-NT*: FW2, non-trout.

*PL*: Pinelands waters. Designated uses are: cranberry bog water supply and other agricultural uses; maintenance, migration, and propagation of the natural and established biota indigenous to this unique ecosystem; Public potable water supply after conventional filtration treatment and disinfection; primary and

secondary contact recreation; and any other reasonable uses. These waters are designated as Outstanding National Resource Waters.

*SE1:* Saline estuarine waters of estuaries. Designated uses are: Shellfish harvesting; maintenance, migration, and propagation of the natural and established biota; primary and secondary contact recreation; and any other reasonable uses.

*SE2:* Saline estuarine waters of estuaries. Designated uses are: maintenance, migration, and propagation of the natural and established biota; migration of diadromous fish; maintenance of wildlife; secondary contact recreation; and any other reasonable uses.

*SE3:* Saline estuarine waters of estuaries. Designated uses: secondary contact recreation; maintenance and migration of fish populations; migration of diadromous fish; maintenance of wildlife; and any other reasonable uses.

*SC:* General surface water classification applied to saline coastal waters. Designated uses: shellfish harvesting; primary and secondary contact recreation; maintenance, migration, and propagation of the natural and established biota; and any other reasonable uses.

Criteria of attainment status for parameters where the required number of samples is available (monitored):

*Full Attainment:* 10% or fewer of the samples exceed applicable SWQS or excursions due to natural conditions.

*Non-Attainment:* Threatened Waters: Fewer than 10% of samples exceed applicable SWQS, but declining water quality trends indicate that SWQS are likely to be exceeded in more than 10% of the samples in 2 years.

*Non-Attainment:* More than 10% of the samples exceed applicable SWQS

Criteria of attainment status for parameters where the required number of samples is not available (estimated):

*Full Attainment:* 10% or fewer of the samples exceed applicable SWQS or excursions due to natural conditions with at least 8 samples.

*Insufficient Data:* 10% or fewer of the samples exceed applicable SWQS or excursions due to natural conditions with less than 8 samples or only one (1) sample exceeds applicable SWQS with less than 10 samples.

*Non-Attainment:* More than 10% of the samples exceed applicable SWQS and two (2) or more samples exceed applicable SWQS.

New Jersey has assigned categories to waterbodies using the EPA's Integrated List categories. However in 2002, New Jersey made some modifications to these categories. The state combined Category 1 (*Waterbodies attain all water quality standards and support all designated uses; no waterbodies are classified as threatened*) and Category 2 (*Waterbodies are attaining some uses, no use is threatened; however, there is insufficient information available to determine if the remaining uses are attained or threatened*) in New Jersey's Integrated Listing in the 2002 listing cycle (NJ 2002b). This was done because of limitations of data gathering efforts that prevented NJ-DEP from being able to fulfill the information requirements of List (Category) 1; specifically, the state was unable to assess all designated uses for all waterbodies due to insufficient data for total

dissolved solids and heavy metals recorded under high flow conditions (largely due to extended drought conditions). Therefore, List 2 (Category 2) was more representative of New Jersey's assessment. The combined list for Categories 1 and 2 represent waterbodies where one or more uses were in full support; other uses may not have been assessed, or there may not have been sufficient data to assess remaining uses. In contrast, waterbodies where there was insufficient data to make any attainment decisions were placed on List 3 (Category 3).

### New York Water Quality Assessment

NPS units within the state of New York are Fire Island National Seashore, Gateway National Recreation Area's Jamaica Bay Unit, and Sagamore Hill National Historic Site.

As of December 2002, the New York State Department of Environmental Conservation (NYS-DEC) had not submitted detailed electronic water quality assessment data in standard format to EPA. As a result the standard 305(b) information on Designated Use Impairments is not available through the EPA. The New York State Water Quality 2000 report (NYS-DEC 2000), submitted as required by Section 305(b) of the Clean Water Act, is available; however, detailed information on Designated Uses was not be available for all listed water bodies.

As summary of New York State's water quality classifications are listed below (NY-DEC 2000):

*Class N fresh surface waters:* Best uses are the enjoyment of water in its natural condition and, where compatible, as sources of water for drinking or culinary purposes, bathing, fishing, fish propagation, and recreation. No discharge of sewage, industrial wastes, or other wastes, waste effluents without filtration are allowed. These waters shall contain no deleterious substances, hydrocarbons or substances that would contribute to eutrophication, nor shall receive surface runoff containing any such substance.

*Class AA-Special (AA-S) fresh surface waters:* A source of water supply for drinking, culinary or food processing purposes; primary and secondary contact recreation; and fishing. These waters shall be suitable for fish propagation and survival. They shall contain no floating solids, settleable solids, oil, sludge deposits, toxic wastes, deleterious substances, colored or other wastes or heated liquids attributable to sewage, industrial wastes or other wastes. No discharge or disposal of sewage, industrial wastes or other wastes are allowed. They shall contain no phosphorus and nitrogen in amounts that will result in growths of algae, weeds and slimes that will impair the waters for the above uses.

*Class A-Special (A-S) fresh surface waters:* A source of water supply for drinking, culinary or food processing purposes; primary and secondary contact recreation; and fishing. These waters shall be suitable for fish propagation and survival. This classification may be given to those international boundary waters that, if subjected to approved treatment, equal to coagulation, sedimentation, filtration

- and disinfection with additional treatment, if necessary, to reduce naturally present impurities, meet or will meet New York State Department of Health drinking water standards and are considered safe and satisfactory for drinking water purposes.
- Class AA fresh surface waters:* A source of water supply for drinking, culinary or food processing purposes; primary and secondary contact recreation; and fishing. These waters shall be suitable for fish propagation and survival. This classification may be given to waters that, if subjected to approved disinfection treatment, with additional treatment necessary to remove naturally present impurities, meet or will meet New York State Department of Health drinking water standards and are considered safe and satisfactory for drinking water purposes.
- Class A fresh surface waters:* A source of water supply for drinking, culinary or food processing purposes; primary and secondary contact recreation; and fishing. These waters shall be suitable for fish propagation and survival. This classification may be given to waters that, if subjected to approved treatment, equal to coagulation, sedimentation, filtration and disinfection, with additional treatment if necessary, to reduce naturally present impurities, meet or will meet New York State Department of Health drinking water standards and are considered safe and satisfactory for drinking water purposes.
- Class B fresh surface waters:* A source of water supply for primary and secondary contact recreation and fishing. These waters shall be suitable for fish propagation and survival.
- Class C fresh surface waters:* Fishing. These waters shall be suitable for fish propagation and survival. Water quality shall be suitable for primary and secondary contact recreation, although other factors may limit the use for these purposes.
- Class D fresh surface waters:* Fishing. Due to such natural conditions such as intermittency of flow, water conditions not conducive to propagation of game fishery, or stream bed conditions, the waters will not support fish propagation. They shall be suitable for fish survival. Water quality shall be suitable for primary and secondary contact recreation, although other factors may limit the use for these purposes.
- Class SA saline marine surface waters:* Shellfishing for market purposes, primary and secondary contact recreation and fishing. These waters shall be suitable for fish propagation and survival.
- Class SB saline marine surface waters:* Primary and secondary contact recreation and fishing. These waters shall be suitable for fish propagation and survival.
- Class SC saline marine surface waters:* Fishing. These waters shall be suitable for fish propagation and survival. Water quality shall be suitable for primary and secondary contact recreation, although other factors may limit the use for these purposes.
- Class I saline marine surface waters:* Secondary contact recreation and fishing. These waters shall be suitable for fish propagation and survival.

NYS-DEC ambient water quality monitoring is supported by the Rotating Intensive Basin Studies (RIBS) Program, which was initiated in 1987 (NY-DEC 2000). The objectives of the RIBS Program include the overall assessment of stream water quality, including the documentation of good quality waters; long-term trend analyses of water quality; comprehensive, multiple parameter sampling; characterization of background conditions; and the establishment of baseline conditions for other site-specific water quality investigations (NYS-DEC 2000). The RIBS program concentrates monitoring activities on one-third of the state's hydrologic basins for 2-year periods. The NY-DEC monitors the entire state every 6 years. The RIBS strategy employs a tiered approach in which biological screening methods are applied at a large number of sites during the first year of a 2-year study, and more intensive chemical monitoring is used to follow up the results of this effort in the second year (EPA 2000). Historically, monitoring had been focused on pollution areas, but in 1998, the RIBS program shifted strategy to place more emphasis on the monitoring and documentation of good quality waters. The RIBS data are currently being processed and warehoused for eventual uploading to EPA's STORET data repository. The RIBS Program is comprised of three separate monitoring networks, each which operates concurrently, yet somewhat independently, and focuses on distinctly different objectives. The monitoring networks are:

*The Routine Network:* This network provides continuous sampling (6 samples annually) of water column chemistry at nineteen selected sites across New York state in order to monitor basin stream characteristics and determine long-term trends in water quality.

*The Intensive Network:* This network employs more frequent water column sampling along with comprehensive, multiple parameter sampling (macroinvertebrates, fish, toxicity testing, bottom sediment chemistry) to provide more detailed assessments of water quality in selected drainage basins.

*The Biological Screening Network:* This network relies upon biological indicators (macroinvertebrates) to provide a qualitative assessment of water quality at a large number of sampling sites in selected basins with minimal analytic expense.

Monitoring data from the state of New York are used to update the Waterbody Inventory/Priority Waterbodies List (WI/PWL). The WI/PWL is an inventory of waterbodies within New York that characterizes known and/or suspected water quality problems and issues, and tracks progress towards their resolution. It is from the WI/PWL that assessments that evaluate whether waters of the state support their designated uses and from which the 305(b) report is compiled. The Waterbody Inventory is a list of water quality information for all waters within the state, while a subset of these waters with well documented, potentially resolvable, higher priority problems are listed in the Priority Waterbodies List (NYS-DEC 2000). The list of waterbodies to be included in the New York Section 303(d) List is drawn from the updated WI/PWL. Waterbodies on the Waterbody Inventory are categorized into one of four Water Quality Assessment Categories (NYS-DEC 2000).

*Category 1, Water Quality Impacted Segments:* Waterbody segments with documented use impairments with a problem severity of precluded, impaired, or stressed.

*Category 2, Threatened Waterbody Segments:* Waterbody segments for which uses are not restricted and no water quality problems exist, but where specific land use or other changes in the surrounding watershed are known to, or strongly suspected of, threatening water quality. Also included in this category are waterbodies designated as Special Protection Waters, which experience no use restrictions or immediate threats to water quality, but remain highly valued resources deemed worthy of special protection and consideration.

*Category 3, Waterbody Impairments Needing Verification:* Waterbody segments that are thought to have a use impairment or water quality impact, but there is not definitive or sufficient documentation.

*Category 4, Waterbodies Having No Known Impairment:* Waterbody segments where monitoring efforts indicate there are no use impairments or other water quality impacts or issues.

Waterbodies in Category 1 or 2 comprise the Priority Waterbodies List. Waterbodies in Category 3 or 4 are tracked on the comprehensive Waterbody Inventory, but are not considered to be on the Priority Waterbodies List. The remaining waters of the state are recorded the Waterbody Inventory as *Unassessed*. Waters assessed as impaired or threatened are evaluated for the appropriateness of TMDL development to address the impairment or threat. Once a TMDL has been developed for a waterbody on the 303(d) List, the water becomes an *impaired or threatened water not requiring a TMDL*, and is, by definition, no longer included on the list, and is de-listed. Some waters assessed as impaired or threatened are not included on the 303(d) List because TMDL development is not the most appropriate response to the water quality issue. Impaired or threatened waters not requiring a TMDL generally fall into the one of the following categories:

*Impaired/Threatened waters where a TMDL is developed and being implemented:* Once a TMDL has been developed and approved, the waterbody is no longer included on the 303(d) List.

*Impaired/Threatened waters where other controls are more suitable:* For some water quality impairments or threats, actions other than TMDL development (e.g. correction of failing or inadequate treatment facilities, implementation of best management practices, zoning restrictions, etc.) provide a more appropriate and effective response.

The assessment of New York waterbodies is based on the ability of the waters to support a range of designated uses. Those designated for the New York are aquatic life, water supply, fish consumption, shellfishing use, public boating, recreational use, and aesthetics (more detailed information on designated used and assessment criteria can be found in the NYS-DEC 2000 document). The severity of use impairment is categorized as one of four categories (NYS-DEC 2000):

*Precluded:* Frequent and/or persistent water quality, or quantity, conditions and/or associated habitat degradation prevents all aspects of the waterbody use.

*Impaired:* Occasional water quality, or quantity, conditions and/or habitat characteristics periodically prevent the use of the waterbody, or; waterbody uses are not

precluded, but some aspects of the use are limited or restricted, or; waterbody uses are not precluded, but frequent/persistent water quality, or quantity, conditions and/or habitat associated habitat degradation discourages the use of the waterbody, or; support of the waterbody use requires additional/advanced measurements or treatment.

*Stressed:* Waterbody uses are not significantly limited or restricted, but occasional water quality, or quantity, conditions and/or associated habitat degradation periodically discourage the use of the waterbody.

*Threatened:* Water quality currently supports waterbody uses and the ecosystem exhibits no obvious signs of stress, however existing or changing land use patterns may result in restricted use or ecosystem disruption, or; monitoring data reveals increasing contamination or the presence of toxics below the level of concern, or; waterbody uses are not restricted and no water quality problems exist, but the waterbody is a highly valued resource deemed worthy of special protection and consideration.

The category “*Waterbodies Having No Known Impairment*” is equivalent to the EPA Designated Use Support category of *Fully Supporting*.

### Virginia Water Quality Assessment

NPS units within the state of Virginia are portions of Assateague Island National Seashore, Colonial National Historical Park, and George Washington Birthplace National Monument.

The Virginia Department of Environmental Quality (VA-DEQ) has issued 305(b) (VA-DEQ 2002a) and 303(d) (VA-DEQ 2002b) reports in the year 2002. Virginia uses the EPAs 305(b) Designated Use Categories (EPA 2000; refer to p. 5). The degree of use for each Designated Use Category for each waterbody or waterbody segment was evaluated and placed into one of five categories, and the percent of the water body that is impaired for that use is estimated. The degree of use for Virginia’s 305(b) listed waters are categorized as follows

*Fully Supporting:* Virginia Water Quality Standard is exceeded in less than or equal to 10% of the measurements taken over the reporting period.

*Partially Supporting:* Virginia Water Quality Standard is exceeded in 11% to 25% of the measurements taken over the reporting period with at least two exceedences.

*Threatened:* Fully supporting but the use has a medium or high probability for adverse conditions and is therefore considered threatened and is a “water of concern”.

*Not Supporting:* Virginia Water Quality Standard is exceeded in more than 25% of the measurements taken over the reporting period with at least two exceedences.

*Not Assessed:* The water body has not been assessed for this designated use.

More detailed information on Virginia’s assessment methodology can be found in Virginia’s 2002 305(b) Water Quality Assessment Report (VA-DEQ 2002b).

Sampling collection and frequency for Virginia's water quality data varies from station to station. The number of stations representing a particular type of stream segment, the types of samples collected, the parameters analyzed, and the sampling frequency all vary depending on site conditions and program emphasis. All stations are monitored for conventional parameters (e.g. dissolved oxygen, pH, temperature, fecal coliform), about one third are monitored for toxics in the sediment, and a smaller number are monitored for toxics in the water column. Areas with potentially greater risk are sampled more frequently: as the risk decreases, the sampling frequency also decreases. Depending on the location water samples are collected either annually, semiannually, quarterly, or monthly. Sediment samples are collected either annually, semiannually, or quarterly (VA-DEQ 2002a). Station specific information for sampling dates, number of visits, and parameters analyzed can be found on the Virginia DEQ Water Quality Monitoring website: <http://www.deq.state.va.us/water/monitoring.html>

Virginia has begun the process of implementing the EPA's Integrated List system. The state has added two categories to the list, 4a "*TMDL Developed*" and 2a "*Waters of Concern*". Virginia is not using "Category 1" since it is the understanding of the state that waters included in this category must have sufficient data to make an assessment for every standard applicable at a monitoring station, and there are no stations in Virginia where every standard is available (VA-DEQ 2002b). In some cases, there were slight discrepancies between the EPA listed reports and those listed by the State. In these cases the most conservative report (the one reporting an impairment) was used and is cited in the 305(b) or 303(d) table for that particular water body.

## Chapter 3 - Acadia National Park

### Water Quality

Acadia National Park (ACAD) occupies the highest rocky headlands on the Atlantic coast of the US and encompasses approximately 16,500 ha in three units (Mount Desert Island, Isle au Haut, and the Schoodic Peninsula). The park's holdings are noncontiguous and are juxtaposed with private lands (Fig. 3-1). There are 14 Great Ponds (water bodies larger than 4 ha), 9 smaller ponds, kettle holes, more than 25 perennial and intermittent streams, and numerous wetlands located partially or entirely within ACAD's boundaries. There are also several natural springs and seeps within the park. The Sieur de Monts spring is an important part of the history of ACAD and was the original focal point for the national monument that eventually became ACAD. No known research has been specifically been conducted on the hydrology and chemistry of the natural springs and seeps within ACAD (Kahl et al. 2000). Most of the park's lakes and ponds are thought to have excellent water quality; but, many may be sensitive to acidification (NPS 1992). Six lakes within or adjacent to ACAD supply drinking water to Mount Desert Island communities, and groundwater supplies water for users within and adjacent to the park (Kahl et al. 2000).

305(b) and 303(d) water quality information for ACAD waters are summarized in Table 3-1. Information in Table 3-1 is a summary from EPA Water Quality Inventory 305(b) and EPA TMDL 303(d) Reports for Maine, Maine 2002 Integrated Water Quality Monitoring and Assessment Report (ME-DEP 2002a), and the Maine 303d List (ME-DEP 1998). Most of the waterbodies within and adjacent to ACAD have insufficient data to determine their 305(b) water quality attainment status so it is not clear which 305(b) designated uses (i.e. aquatic life support, fish consumption, primary contact recreation) are supported for these waters (Table 3-1, Fig. 3-1). However, all waterbodies within the park are exposed to impacts resulting from development within or adjacent to park lands, including sewage disposal and non-point source pollution (NPS 2000). The marine and estuarine waters adjacent to ACAD fall within the state of Maine's fish and shellfish consumption advisory for all marine waters for lobster tomalley, striped bass, and bluefish, therefore all marine waters, including those adjacent to ACAD are listed as impaired by legacy pollutants (e.g. dioxins, PCBs, mercury) (ME-DEP 1998). Due to the migratory nature of these organisms, it is difficult to identify and quantify the source of the contaminants that cause these advisories (ME-DEP 1998). Coastal ponds, lakes, and rivers of ACAD fall under the freshwater fish consumption advisory for all freshwaters within the state of Maine due to the presence of elevated mercury levels in fish tissue. Although Maine has and continues to control local sources of mercury, most of the mercury sources are from air emissions, the majority of which originate beyond the state's border via long range atmospheric transport and deposition (ME-DEP 1998), as a result all freshwaters within ACAD are listed as impaired. Bar Harbor has issues with combined sewer overflows, however there are current master plans for abatement. Bass Harbor, Eastern Duck Cove, and Frenchman's Bay are closed to shellfishing due to bacteria and/or toxics (Table 3-1).

Based on the National Park Service Water Resource Division and Servicewide Inventory and Monitoring Program (NPS-WRD 1995a), ACAD has surface water quality typical for New England coastal mountain region, however, its near-pristine water resources are potentially threatened by expanding development, landfills, and acid deposition.

### Outstanding Resource Waters

Outstanding Resource Waters (ORW) are classified by the Maine Department of Environmental Protection as Class SA waters (estuarine and marine), Class GPA (lakes), and Class AA (riverine) (ME-DEP 2002b). The state lists all brooks, streams, and segments of those brooks and streams that are within the boundaries of ACAD as Class AA waters, however these same waters are also covered by the freshwater fish consumption advisory due to the presence of elevated mercury levels in fish tissue. Similarly, those marine and estuarine waters classified as ORW by the State of Maine (Class SA) are also classified as impaired under the statewide shellfish consumption advisory for all marine waters due to contaminants (dioxins, PCBs, mercury). Six lakes within or adjacent to its boundaries have been designated as public drinking resources (NPS 2000).

The following waters are considered to be ORW within ACAD:

All brooks, streams, and segments of those brooks and streams that are within the boundaries of Acadia National Park (Class AA).

Bar Harbor (state ID: 714-6): Tidal waters, except those lying within 500 feet of privately owned shoreline, lying northerly of latitude 44°-16'-36" N., southerly of latitude 44°-20'-27" N., and westerly of longitude 68°-09'-28" W. (Class SA).

Cranberry Isles (state ID: 714-2): Tidal waters, except those lying within 500 feet of privately owned shoreline, lying within 0.5 mile of the shore of Baker Island (Class SA).

Mount Desert (state ID: 714-3): Tidal waters, except those lying within 500 feet of privately owned shoreline, lying northerly of latitude 44°-16'-36" N. and easterly of longitude 68°-13'-08" W. (Class SA).

Mount Desert (state ID: 714-3): Tidal waters of Somes Sound lying northerly of a line beginning at a point located at the Acadia National Park boundary at latitude 44°-18'-18" N., longitude 68°-18'-42" W. and running northeasterly to a point located at the Acadia National Park boundary at latitude 44°-18'-54" N., longitude 68°-18'-22" W., except those waters of Broad Cove lying west of a line running from the point of land immediately south of the cove northerly to Navigation Can #7 and those waters lying within 500 feet of overboard discharges licensed as of January 1, 1999 (Class SA).

Mount Desert coastal lakes (Class GPA).

Otter Cover, Bar Harbor (state ID: 714-5) (Class SA).

Somes Sound (state ID: 714-3): Tidal waters of Somes Sound lying within 500 feet of overboard discharges licensed as of January 1, 1999 (Class SA).

Southwest Harbor (state ID: 714-1): Tidal waters lying northerly of latitude 44°-12'-44" N., southerly of latitude 44°-14'-13" N. and westerly of longitude 68°-18'-27" W. (Class SA).

Southwest Harbor (state ID: 714-1): Tidal waters of Somes Sound lying northerly of a line beginning at a point located at the Acadia National Park boundary at latitude 44°-18'-18" N., longitude 68°-18'-42" W. and running northeasterly to a point located at the Acadia National Park boundary at latitude 44°-18'-54" N., longitude 68°-18'-22" W. (Class SA).

Tremont (State ID: 714 & 707): Tidal waters lying northerly of latitude 44°-12'-44" N., southerly of latitude 44°-14'-13" N. and easterly of longitude 68°-20'-30" W. (Class SA).

Winter Harbor (state ID: 714-17): Tidal waters lying south of a line running west from the northernmost tip of Frazer Point to longitude 68°-05'-00" W. and east of longitude 68°-05'-00" W. (Class SA).

### Wetland Area

Wetland types include salt and freshwater marshes, sphagnum-sedge and scrub bogs, alder scrub, and black spruce-tamarack swamps. Wetland areas of note include Northeast Creek, Great Meadow, Marshall Brook/Bass Harbor Marsh, and Bliss Field (NPS 1992; NPS 2000).

Total wetland area (forested and non-forested) within ACAD is 1207 hectares, comprising 8% of the total vegetation (Table 3-2). Detailed descriptions for forested and non-forested wetlands [Land Use Codes (LUC) codes 61 and 62] are given in Table 3-3. Impaired waters influence an estimated 324 ha of forested wetlands and 232 ha of non-forested wetlands. A detailed summary of the potential impairments to ACAD wetlands is given in Table 3-4.

### Wetland and Water Quality Issues

#### *All Habitats and Waters*

Water resources within ACAD are generally considered healthy and well suited to their uses. However, ACAD is among the top ten most visited parks in the nation and as such water resources are vulnerable to direct usage, or inappropriate watershed use (Kahl et al. 2000). Issues such as drinking water supply, waste water treatment, flow control structures, swimming, boating, and sight-seeing activities affect water resources through

consumptive withdrawals, waste water discharges, manipulation of water levels, and the introduction of pollutants and non-native aquatic plants and animals. All of the waters within and adjacent to ACAD may be impacted by oil and hazardous waste spills, landfill activity, high visitor use, and atmospheric deposition (Kahl et al. 2000; NPS 2000). Eutrophication, invasive and non-native species, illegal plant and animal collection, trampling, and the potential for oil spills are all threats to wetland and estuarine/marine environments. Watershed management issues are a concern within ACAD. Since only a portion of the major drainage systems on Mount Desert Island are located within park boundaries, activities taking outside the park can significantly impact waters within ACAD. Inadequate disposal of waste water is one of the largest local threats to park water quality. Visitor services, if not properly designed, can contribute to non-point pollution and surface runoff may also be a potential problem (Kahl et al. 2000).

### *Freshwater*

Freshwater lakes and ponds of ACAD are vulnerable to acidification. Most of the surface waters within ACAD are poorly buffered and oligotrophic making them susceptible to acidification from atmospheric deposition (Kahl et al. 2000). Over the past 15 years several studies have been conducted to document the effects of atmospheric and marine aerosol deposition on ACAD waterbodies. Despite significant reductions in sulfur dioxide emissions and sulfate deposition during the past decade as a result of the Clean Air Act Amendments of 1990, the pH and acid neutralizing capacity of park waters remains unchanged (NPS 2000). Complex jurisdictional issues over the recreational use and management of surface waters has the potential to create management conflicts between the National Park Service and the State of Maine over hunting, trapping, fish stocking, and recreational (boating) use on the Great Ponds. Protection of local drinking water supplies within and adjacent to ACAD must be protected from non-point and point sources of pollution. Ensuring that swimming locations are free of bacterial contamination is also an essential park management objective (Kahl et al. 2000).

### *Estuarine and Marine*

Bass Harbor Marsh and Northeast Creek (also called Fresh Meadow) are expansive marsh systems of salt marsh, tidal fresh wetlands, and submerged aquatic beds of *Ruppia maritima* (Kopp et al. 2002). Bass Harbor Marsh is beginning to show signs of eutrophication from increased nutrient loading from freshwater tributaries (Doering et al. 1995; Kinney and Roman 1998). Northeast Creek, is relatively pristine in terms of nitrogen loading (Nielsen 2002), but is threatened by the growth of residential development in the surrounding watershed (Kopp et al. 2002).

## Monitoring Programs (Table 3-5)

### *Freshwater Monitoring*

Lake monitoring by park staff, in cooperation with the Maine Department of Environmental Protection (DEP), began in the late 1970's and continues to present day in

selected lakes on Mount Desert Island. Variables that are monitored include: temperature, dissolved oxygen, transparency, pH, specific conductance, alkalinity, color, total phosphorus, total nitrogen, chlorophyll-*a*, lake stage, and light penetration (NPS 2000). The Maine Volunteer Lake Monitoring Program monitors two ponds (Bubble and Jordan Ponds) within ACAD (Williams 1999). Volunteers collect data (temperature, dissolved oxygen, total phosphorus, chlorophyll-*a*, pH, alkalinity, specific conductance, and Secchi depth) every two weeks from May to October. Historical data are also available for these ponds (Williams 1999).

Benthic stream macroinvertebrate monitoring was initiated in 1997 by the Maine DEP and continues to present. Monitoring parameters include benthic macroinvertebrates, habitat characterization, stream temperature, pH, dissolved oxygen, specific conductance, color, and flow rate (Kahl et al. 2000; NPS 2000). Through a cooperative agreement between the Maine DEP and the NPS, six sampling stations (Cannon Brook, Duck Brook, Heath Brook, Hunter's Brook, Lurvey Spring Brook, and Stanley Brook) have been added within ACAD on Mt. Desert Island since 1996. During the 1997 to 1999 sampling period, Lurvey Spring Brook and Heath Brook were assessed below their state listed legal classes. Both streams are supposed to be a Class AA waters (ORW) but Lurvey Spring Brook was modeled as a Class B water, and Heath Brook was modeled as a Class C water (Davies et al. 1999). The region (St. Croix and North Coastal Basins) was due for intensive sampling in 2001 as part of a five year rotational sampling program of the (Davies et al. 1999).

Biological inventory and monitoring data are still limited for ACAD streams and do not meet the minimum NPS Level I requirements for inventories of freshwater fish (Kahl et al. 2000).

Various other studies on water quality and biota of ACAD streams and lakes have been conducted over the past two decades, however these are short studies lasting only a few or more years. These studies are summarized in Kahl et al. (2000) and in NPS (2000).

The USGS maintains a National Water Information System (NWIS) water quality website, NWISweb Data for the Nation, where realtime data and archived data on surface water flow and levels in streams, lakes, springs, groundwater well levels, and water quality data from approximately 1.5 million stations nationwide can be queried (USGS 2004). The USGS has two active continuous record, surface-water gaging stations within ACAD. One at Cadillac Brook near Bar Harbor (USGS 01022835) and one at Hadlock Brook near Cedar Swamp Mountain and Northeast Harbor (USGS 01022860). Both have been recording data from 1999 through the present.

The National Park Service Water Resource Division and Servicewide Inventory and Monitoring Program conducted a baseline water quality data inventory and analysis of all surface waters (fresh, estuarine, and marine) for ACAD (NPS-WRD 1994a). Sixteen water quality stations were located within the study area, and 10 of these were located within the park's boundary. The technical report presents the results of surface-water-quality data retrievals for ACAD from five of the US EPA's national databases:

- Storage and Retrieval (STORET) database management system: Water quality parameter data, locations of sampling stations, descriptive elements about stations and parameters
- River Reach File (RF3): 1:100,000 scale geographical representation of surface waters (rivers, lakes, etc) with a unique identifier assigned to each surface water segment and connectivity information useful for routing and navigation.
- Industrial Facilities Discharge (IFD): Locations of industrial and municipal point source discharge facilities.
- Drinking Water Supplies (DRINKS): Locations of intake pipes for drinking water supplies.
- Stream Gages (GAGES): Locations of USGS and other discharge gages.

Provided within the ACAD technical report are: 1. complete inventory of all retrieved water quality parameter data, water quality stations, and the entities responsible for data collection; 2. descriptive statistics and appropriate graphical plots of water quality data characterizing annual and seasonal central tendencies and trends; 3. a comparison of ACAD's water quality data relevant to EPA and WRD water quality screening criteria; 4. an Inventory Data Evaluation and Analysis (IDEA) to determine what Servicewide Inventory and Monitoring Program Level I water quality parameters have been measured within the study area (NPS-WRD 1994a). Level I water quality parameters identified by the Servicewide Inventory and Monitoring program were: alkalinity, pH, conductivity, dissolved oxygen, and rapid bioassessment baseline for fish and macroinvertebrates. Optional case-by-case parameters included toxic elements, clarity/turbidity, nitrate/nitrogen, phosphate/phosphorus, chlorophyll, sulfates, and bacteria (NPS-WRD 1994a). The IDEA conducted for ACAD indicated that STORET data exists for all Level I parameter groups in the study area except for flow and bacteria. Generally, limited monitoring stations and data are available, with most data collected from 1975 through 1984, and no data were available after this time (NPS-WRD 1994a). The results of the ACAD water quality criteria screen found 4 parameters that exceeded the screening criteria at least once within the study area. Dissolved oxygen, pH, and copper exceeded their respective EPA acute or chronic criteria for the protection of aquatic life. Copper exceeded the EPA drinking water criterion once. Alkalinity was below the threshold used by the NPS Air Quality Division for determining potential sensitivity to acid deposition (buffering capacity) 3 times (NPS-WRD 1994a).

#### *Estuarine and Marine Monitoring*

Various studies on water quality and biota of ACAD estuaries and salt marshes have been conducted over the past two decades; however these are short studies lasting only a few or more years. These studies are summarized by Kahl et al. (2000). Distribution maps of eelgrass are available from the State of Maine Department of Marine Resources. However, this mapping effort did not include brackish waters and the associated submerged aquatic communities (i.e. *Ruppia maritima*) (Kopp et al. 2000).

ACAD may select to implement long-term monitoring protocols for salt marsh vegetation and estuarine nekton (Roman et al. 2001; Raposa & Roman 2001) developed at Cape Cod

National Seashore for the Long-Term Monitoring Program. If selected, monitoring will take place in the summer of 2005. These data will serve as baseline data and it is hoped that the sites will be sampled long-term.

Under the EPA's Environmental Monitoring and Assessment (EMAP) and The National Coastal Assessment – Coastal 2000 program water quality was at several monitored in the marine waters adjacent to ACAD in 2000. A map of stations adjacent to ACAD is shown in Fig 3-2. Specific parameters that are monitored include (EPA EMAP website; Coastal 2000):

- Water quality: dissolved oxygen, salinity, temperature, depth, pH, nutrients, chlorophyll
- Sediment quality: grain size, total organic carbon, sediment chemistry, benthic community structure, sediment toxicity
- Biota: benthic community structure, fish community structure, fish external pathology, fish tissue analyses

#### *Other Monitoring Data Sources*

ACAD is part of the Park Research and Intensive Monitoring of Ecosystems Network (PRIMENet) program. This is cooperative program between the US EPA and the National Park Service for cooperative long-term research and monitoring to assess the effects of environmental stressors on ecological resources. ACAD is one of 14 National Park Units that have been established as regional index sites to monitor environmental stressors and related ecosystems responses. The PRIMENet program includes air and water monitoring, and additionally UVB monitoring, to assess the potential impacts of UVB on amphibian populations (NPS 2000).

ACAD has both a National Atmospheric Deposition Program (NADP) and a Mercury Deposition Network (MDN) station (station # ME98) within its boundaries (McFarland Hill). The NADP station has been in operation since 1980 and the MDN station has been in operation since 1995. Over the past 15 years several studies have been conducted to document the impacts of atmospheric and marine aerosol deposition on ACAD waters (e.g. Heath et al. 1992; Kahl et al. 1989; NPS 2000).

Land use and land cover data are available from the NOAA Coastal Change Analysis Program and the Multi-Resolution Land Characteristics Consortium (Kopp et al. 2002). The National Wetlands Inventory (NWI) updated its wetland mapping of Acadia region in 1994 (Calhoun et al. 1994). Detailed vegetation maps of the park, developed from aerial photography flown in 1997, are available from the park's GIS specialist.

Table 3-1. Water Quality Attainment Status for State Designated Uses [305(b) waters] and Impaired Waters [303(d) listed] for Acadia National Park. Information is a summary from EPA Water Quality Inventory 305(b), EPA TMDL 303(d) Reports, Maine 2002 Integrated Water Quality Monitoring and Assessment Report, and the Maine 303d List (ME-DEP 1998). If a 305(b) ID is not listed then the corresponding 305(b) report for that segment of the water body could not be found. Note: 305(b) water quality attainment information could not be found for these waterbodies. None of these water bodies had TMDL's reported to EPA by Maine. "na" indicates information could not be found.

Waterbody	Listing Cycle	305 b Assessment Unit ID	303(d) List ID	Integrated List Category & Class	Water Quality Attainment Status for State Designated Uses & Impairment
All Coastal Waters*	1998	na	ME9986_C	na	<b>Fish consumption advisory</b> <b>Water Impairments:</b> dioxin, mercury, PCBs <b>Source:</b> none listed
All Rivers and Lakes**	1998	na	ME9985_LR	na	<b>Fish consumption advisory</b> <b>Water Impairments:</b> mercury <b>Source:</b> atmospheric deposition
Arey Cove, Winter Harbor	2002	714-18 ( <i>state ID</i> )	na	3, SB	Insufficient data to determine attainment
Bar Harbor <i>Ogden Pt to W side of Bald</i> <i>Porcupine Is to S side bar</i> <i>Is &amp; directly E to Mt</i> <i>Desert Is.</i>	2002	714-21 ( <i>state ID</i> )	na	4-B2, SB	Combined sewer overflows with current master plans for abatement
Bar Harbor	2002	714-6 ( <i>state ID</i> )	na	3, SB	Insufficient data to determine attainment
Bass Harbor & Eastern Duck Cove, Tremont	2002	707-6 ( <i>state ID</i> )	ME-Area #42	5, SB	<b>Non Attainment:</b> Closed to shellfishing <b>Water Impairments:</b> bacteria, toxics <b>Source:</b> none listed

Waterbody	Listing Cycle	305 b Assessment Unit ID	303(d) List ID	Integrated List Category & Class	Water Quality Attainment Status for State Designated Uses & Impairment
Bass Harbor Head, Tremont to Schoodic Pt, Winter Harbor	2002	714 & 707 (state ID)	na	2, SB/SC	Attaining some uses, insufficient data for other uses
Broad Cove & Somes Harbor, Mt Desert	2002	714-3 (state ID)	na	3, SB/SA	Insufficient data to determine attainment
Frenchman's Bay	1998	na	ME-T1B0004	na	<b>Non Attainment:</b> Closed to shellfishing <b>Water Impairments:</b> bacteria <b>Source:</b> none listed  <i>Note: Bar Harbor is under enforceable actions to develop and implement long term control plans for combined sewer overflows to meet water quality standards for bacteria</i>
Grindstone Neck, Winter Harbor	2002	714-19 (state ID)	na	3, SB	Insufficient data to determine attainment
Long Pond, Mount Desert	na	na	na	na	<i>Listed on previous 303d list but has been removed since current data indicate this water has attained water quality standards</i>
Mt Desert coastal lakes	2002	na	na	2, GPA	Attaining some uses, insufficient data for other uses
Mt Desert coastal rivers-tributaries entering from Mt Desert and adjacent islands	2002	514R (state ID)	na	2, AA, A, B	Attaining some uses, insufficient data for other uses
Northwest Cove, Bar Harbor	na	na	na	na	<i>Listed on previous 303d list but has been removed since current data indicate this water has attained water quality standard and is open to shellfishing</i>
Otter Cover, Bar Harbor	2002	714-5 (state ID)	na	3, SB/SA	Insufficient data to determine attainment
Salisbury Cove, Bar Harbor	2002	714-8 (state ID)	na	3, SB	Insufficient data to determine attainment
Schoodic Pt, Winter Harbor to Petit Manan Pt, Steuben	2002	706 (state ID)	na	2, SB	Attaining some uses, insufficient data for other uses

Waterbody	Listing Cycle	305 b Assessment Unit ID	303(d) List ID	Integrated List Category & Class	Water Quality Attainment Status for State Designated Uses & Impairment
Seal Harbor	2002	714-4 ( <i>state ID</i> )	na	3, SB	Insufficient data to determine attainment
Southern Mt Desert Island & Cranberry Isles	2002	714-2 ( <i>state ID</i> )	na	3, SB/SA	Insufficient data to determine attainment
Southwest Harbor	2002	714-1 ( <i>state ID</i> )	na	3, SB	Insufficient data to determine attainment
Thomas Bay, Bar Harbor	2002	714-7 ( <i>state ID</i> )	na	3, SB	Insufficient data to determine attainment
Tinker Brook, West Tremont	2002	707-11 ( <i>state ID</i> )	na	3, SB	Insufficient data to determine attainment

**Fish consumption advisories:**

- \* Maine has fish and shellfish consumption advisories for all marine waters for lobster tomalley, striped bass, and bluefish, therefore all marine waters are listed as Category 5-D due to this contamination problem. Due to the migratory nature of these organisms, it would be difficult to identify and quantify the source of the contaminants (dioxins, PCBs, mercury) that causes these advisories, therefore, it is technically infeasible to perform a TMDL analysis.
- \*\* Maine currently has a fish consumption advisory for all freshwater due to the presence of elevated mercury levels in fish tissue, therefore all freshwaters were listed Category 5-C due to this contamination problem. Most mercury sources are air emissions,

Note: Frenchman's Bay (ME-T1B0004) and Bar Harbor (714-21) may be the same waterbody.

Website addresses:

EPA Water Quality Inventory 305(b) website: <http://www.epa.gov/waters/305b/index.html>

EPA TMDL 303(d) Reports: <http://www.epa.gov/waters/tmdl/index.html>

Maine 303(d) List: <http://www.state.me.us/dep/blwq/docmonitoring/impairedwaters/index.htm>

Maine 2002 Integrated Water Quality Monitoring and Assessment Report: <http://www.state.me.us/dep/blwq/docmonitoring/305bappendix.pdf>

Table 3-2. Total hectares (from GIS coverages) for land use classifications (LUC codes) for ACAD (includes parcels of land designated for future acquisition). Areas calculated from ACAD GIS coverages (based on 1997 aerial photography ).

<b>LUC_II code description</b>	<b>Total hectares</b>	<b>Percent</b>
11 – Residential	29.6	0.2%
12 – Commercial and Services	109.6	0.7%
14 – Transportation, Communications, and Utilities	66.8	0.4%
16 – Mixed Urban or Built-up Land	73.6	0.5%
17 – Other Urban or Built-up Land	6.3	0.0%
24 – Other Agricultural Land	5.6	0.0%
31 – Herbaceous Rangeland	62.6	0.4%
32 – Shrub and Brush Rangeland	426.6	2.8%
41 – Deciduous Forest Land	1979.9	12.8%
42 – Evergreen Forest Land	5864.1	38.0%
43 – Mixed Forest Land	5085.8	33.0%
52 – Lakes	272.0	1.8%
54 – Bays and Estuaries	94.1	0.6%
61 – Forested Wetland	877.9	5.7%
62 – Nonforested Wetland	328.9	2.1%
74 – Bare Exposed Rock	112.0	0.7%
75 – Strip Mines, Quarries, and Gravel Pits	7.7	0.1%
No Data	9.4	0.1%

Table 3-3. Detailed descriptions and areas for forested and non-forested wetlands and total hectares adjacent to impaired waterbodies [Land use Codes (LUC) codes 61 and 62 in Table 3-2). Areas calculated from ACAD GIS coverages (based on 1997 aerial photography ).

<b>Detailed wetland vegetation (LUC 61 &amp; 62) descriptions</b>	<b>Total hectares</b>	<b>Hectares adjacent to impaired waters</b>	<b>Percent wetland type adjacent to impaired waters</b>
<i>Forested Wetlands (LUC 61)</i>			
Alder Shrubland	62.8	25.6	40.7%
Conifer Swamp Woodland (spruce-mixed phase)	311.1	44.3	14.2%
Conifer Swamp Woodland (white cedar phase)	67.9	14.2	20.9%
Dwarf Shrub Bog	40.1	0	0.0%
Fen Complex	271.1	177.6	65.5%
Red Maple – Hardwood Swamp	69.0	26.8	38.8%
Sweetgale Mixed Shrub Fen	55.8	35.9	64.4%
<i>Non-forested Wetlands (LUC 62)</i>			
Graminoid Shallow Marsh	102.5	80.6	78.6%
Open Water – Deep Marsh Complex	89.6	87.3	97.5%
Tidal Marsh	64.4	64.4	100.0%

Table 3-4. Total hectares (and percent of wetland type) of wetlands adjacent to 303(d) listed waterbodies within ACAD. Areas calculated from ACAD GIS coverages.

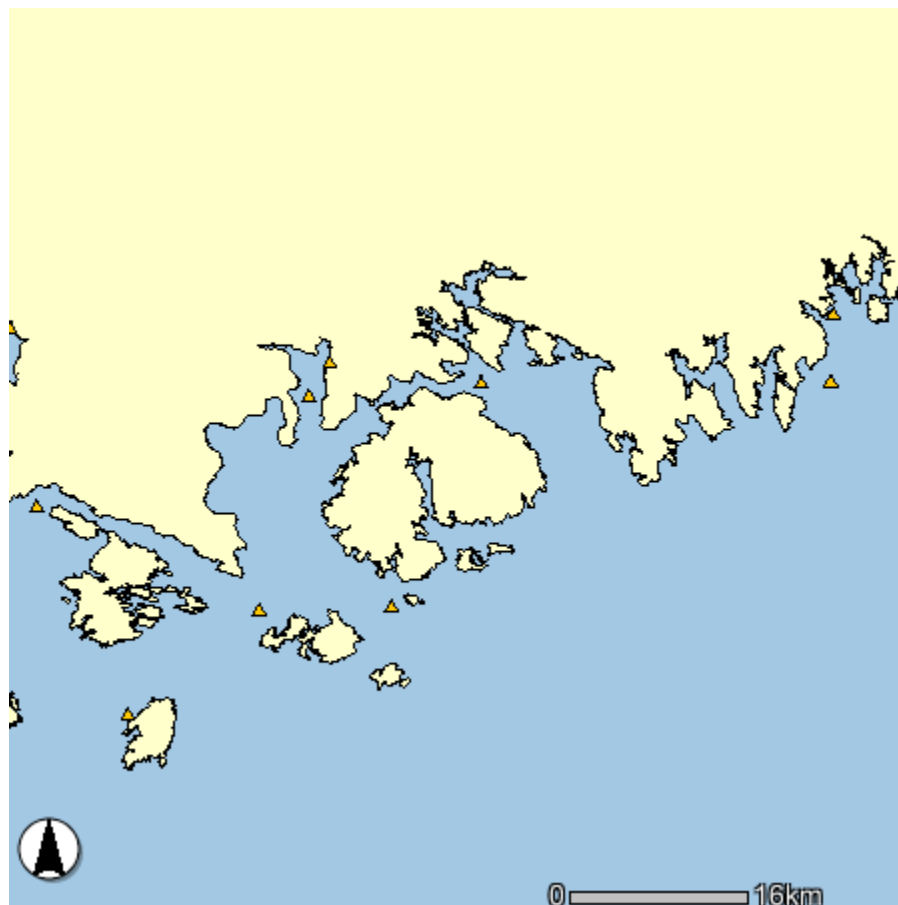
<b>Waterbody</b>	<b>Impairment</b>	<b>Forested wetlands (LUC 61)</b>	<b>Non-forested Wetlands (LUC 62)</b>	<b>Total wetlands</b>
Bass Harbor & Duck Cove	bacteria and toxics	9.5 (1%)	39.3 (3%)	48.8
Coastal waters (Frenchman Bay, Bar Harbor)	dioxin, mercury (fish consumption advisory), and PCBs	64.1 (5%)	65.9 (5%)	130.0
Freshwater lakes & ponds	mercury (fish consumption advisory)	250.7 (21%)	127.1 (11%)	377.8
Other wetlands	Not 303(d) listed	553.6 (46%)	96.6 (8%)	650.2

Table 3-5. Summary of long-term wetland or water quality monitoring programs within ACAD. MDN: Mercury Deposition Network; ME-DEP: Maine Department of Environmental Protection; NADP: National Atmospheric Deposition Program; NPS: National Park Service; USGS: US Geological Survey

Monitoring Program		Time period	Agency	Data available
Atmospheric Deposition		NADP: 1980 to present MDN: 1995 to present	NPS	Wet deposition ( $K^+$ , $Na^+$ , $Ca^{+2}$ , $Mg^{+2}$ , $NO_3^-$ , $Cl^-$ , $SO_4^{2-}$ , $PO_4^{3-}$ , $NH_4^+$ , $H^+$ ); Mercury deposition
Benthic macroinvertebrates	stream	1997 to 1999 (5-year rotational sampling due in 2001)	NPS/ ME-DEP	Benthic macroinvertebrates, habitat characterization, stream temperature, pH, dissolved oxygen, specific conductance, color, and flow rate
Lake monitoring		Late 1970's to present	NPS	Temperature, dissolved oxygen, transparency, pH, conductance, alkalinity, color, phosphorus, nitrogen, chlorophyll-a, lake stage, light penetration
National Water Information System (NWIS)		1999 to present	USGS	surface water flow and levels in streams, lakes, springs, groundwater well levels, and water quality data.



Figure 3-1. Map of Acadia National Park and surrounding waters. Stars indicate 303(d) listed waters.



▲ National Coastal Assessment-Northeast sampling stations

Figure 3-2. Map of sampling stations for the Environmental Monitoring and Assessment Program (EMAP) near ACAD National Park. Stations were sampled in 2000. Station data depicted above were produced by the U.S. Environmental Protection Agency through its EMAP Program, <http://www.epa.gov/emap>.

## Chapter 4 -Assateague Island National Seashore

### Water Quality

Assateague Island National Seashore (ASIS) is a 60km long barrier island (Assateague Island) off the coast of Maryland and Virginia. The authorized boundary of ASIS encompasses 20,848 ha, including approximately 13,238 ha of water (the Chincoteague-Sinepuxent Bay complex and the Atlantic Ocean) adjacent to the barrier island as well as 7,610 ha of land area of the island (NPS 1991a). While the National Park Service does not own the submerged lands within Chincoteague-Sinepuxent Bay complex and Atlantic Ocean, they do have jurisdiction over the water column and surface waters within the boundary (C. Zimmerman, NPS, personal communication). The northern and central portions of Assateague Island (3,209 ha) are administered by the NPS, whereas the southernmost portion of the island is administered by the U.S. Fish and Wildlife Service as Chincoteague National Wildlife Refuge (3,994 ha). The Maryland Department of Natural Resources (MD-DNR) manages Assateague State Park (282 ha), which splits ASIS into northern and central sections (NPS 1991a). On the barrier island there are many salt marsh pools within the island's salt marshes, however there are limited number of true freshwater waterbodies. Many of these interior ponds vary from fresh to brackish depending on the season, rainfall amounts, and frequency of storm overwash events (C. Zimmerman, NPS, personal communication).

305(b) and 303(d) water quality information for ASIS waters are summarized in Table 4-1. Information is a summary from EPA Water Quality Inventory 305(b), EPA TMDL 303(d) Reports, Virginia Department of Environmental Quality 2002 305(b) and 303(d) Reports (VA-DEQ 2002a; 2002b), Maryland Department of Natural Resources 305(b) Water Quality Report (MD-DNR 2000), and Maryland's Department of the Environment 2002 303(d) List (MDE 2002). Chincoteague, Sinepuxent and Newport Bays are impaired by fecal coliform, nutrients, and low dissolved oxygen from point, non-point, and natural sources and portions of each bay are closed to shellfishing (Table 4-1). The waters of Assateague Channel, Sheepshead Creek, and Tom's Cove have a Virginia Department of Health (VDH) shellfish restriction imposed on them due to non-point source pollution (Table 4-1). The majority of wetlands within ASIS receive water from these bays, and are mostly impacted by these same impairments (Fig 4-1).

Based on the National Park Service Water Resource Division and Servicewide Inventory and Monitoring Program (NPS-WRD 1995a), surface waters within ASIS are generally of good quality with some indications of impacts from human activities (however, this report is dated and the most current information from the EPA and MD-DNR indicates impaired water quality as described in Table 4-1). Potential sources of contaminants include increasing coastal development, septic systems, recreational usage, marinas, and agricultural runoff in the coastal watershed of the Delmarva Peninsula (NPS-WRD 1995a). The MD-DNR found no water quality impairments in the 250 square km area of the North Atlantic Ocean extending three miles seaward from the Maryland coastline between Delaware and Virginia (MD-DNR 2000).

### Outstanding Resource Waters

Maryland classifies Outstanding National Resource Waters (ONRW) as waters that are high quality waters that constitute an outstanding national resource, such as those waters of National and State parks, wildlife refuges, and waters of exceptional recreational and ecological significance (Code of Maryland Regulations website). As of this writing Maryland has not designated any ONRW. Virginia classifies Outstanding Resource Waters as Significant Lakes. There are no Significant Lakes within ASIS.

### Wetland Area

Wetland vegetation within ASIS comprises 46.5% (1676 ha) of the area of ASIS, all of which is non-forested (Table 4-2). Since the only 303(d) listed waterbodies adjacent to ASIS are estuarine and marine coastal embayments, it likely that all estuarine wetlands are impacted by these impaired waters. Approximately 1675 ha of estuarine non-forested wetlands within ASIS lands are impacted (Table 4-3).

### Wetland and Water Quality Issues

#### *All Habitats and Waters*

ASIS is an undeveloped barrier island and as such land use within the park has much less influence on the nutrient status of these bays than does the land use on the adjacent mainland areas of Maryland and Virginia (Kopp et al. 2000). Recent developments outside ASIS in traditionally rural, undeveloped, sparsely populated areas (Worcester and Accomack Counties) have raised concerns about the potential impacts on water quality in the Chincoteague-Sinepuxent Bay complex. Those activities include (NPS 1991a): marinas and the associated pollutants (gasoline, oil, greywater, sewage, heavy metals); non-point source pollution from poultry and agriculture operations (nitrogen, phosphorus, suspended sediment, and other agriculture non-point source pollutant inputs); increasing residential development (suspended sediment, zinc, cadmium, lead, oil, pesticide, herbicide inputs); point and non-point source loading of nitrogen (especially Trappe Creek). The outlet of Trappe Creek and Newport Bay has been identified as water quality problem area due to elevated nutrient and bacteria levels (NPS 1991a).

Additionally, land use activities within ASIS could potentially impact water quality. These activities include (NPS 1991a): chemical and flushing toilets in camping units and waste disposal facility (fecal coliform and other chemical inputs); two visitor centers and associated housing, maintenance yards, sewage and water treatment plants, and parking lots (fecal coliform, gasoline, oil, suspended sediment, and other pollutants). With the exception of one septic system that serves the north beach day use area and Ranger station, all sanitary waste is removed from the island and treated in the park's waste water treatment plant at ASIS's mainland Maryland headquarters. At present, the one NPDES-permitted septic system facility discharges treated effluent into Sinepuxent Bay. By 2005 the plant will be retrofitted to use constructed wetlands for final treatment (nutrient removal) and disposal, thereby eliminating all discharge into the bay (C. Zimmerman, NPS, personal communication).

Sinepuxent Bay and the northern portion of Chincoteague Bay are managed by the Maryland Coastal Bays Program (MCBP) as a National Estuary Program (NEP) estuary (Kopp et al. 2000). The Maryland Coastal Bays Program is a Federal, State, and local partnership whose mission is to preserve and protect Isle of Wight, Assawoman, Sinepuxent, Newport, and Chincoteague Bays plus the 23 creeks and tributaries that feed the bays. Both Chincoteague Bay and Sinepuxent Bay watersheds are listed as a Category 1 and Category 3 watersheds by the Maryland Clean Water Action Plan [Clean Water Action Plan Technical Workgroup (CWAPTW) 1998)]. Category 1 watersheds are defined as those watersheds not meeting clean water and other natural resource goals and needing restoration. Category 3 watersheds are pristine or sensitive watersheds that are in need of extra protection. Chincoteague Bay received this rating due to historic wetland loss (estimated at 11,600 ha) and its 303(d) listing. Sinepuxent Bay received its rating due to a high percent (79%) of unbuffered streams and its 303(d) status (MD-DNR website). Five major environmental problems facing the coastal bays identified by the MCBP: degraded water quality, loss of habitats, changes in living resources, unsustainable growth and development, and poorly planned recreational use. The MCBP identified that nutrient and sediment enrichment issues were the most important environmental problems (MCBP 1999). The majority of non-point sources of nitrogen come from agricultural runoff (51%) and atmospheric deposition (32%) (MCBP 1998). Point sources include five sewage treatment plants and three permitted industrial discharges.

#### Monitoring Programs (Table 4-5)

##### *Freshwater Monitoring*

As of 2002, there were no regular, long-term State water monitoring programs sampling the non-tidal rivers and streams in the area surrounding ASIS (MD-DNR 2000). The USGS in cooperation with the NPS has conducted a study of the transport of nutrients in groundwater in the surficial aquifer to estuaries adjacent to ASIS (Dillow et al. 2002; Dillow and Greene 1999). As part of this study ground-water monitoring wells were installed within ASIS. Water-level and water quality data were collected at various depths from these wells once per month from October 1999 through November 2000 (Dillow et al. 2002). One USGS stage-discharge monitoring station is in operation and an expanded network has been proposed (Kopp et al 2002).

##### *Estuarine and Marine Monitoring*

Water quality monitoring in the Chincoteague-Sinepuxent Bay complex was initiated by the National Park Service at ASIS in 1987 and continues to present (NPS 1991a), although temperature and salinity observations of the Chincoteague-Sinepuxent Bay complex date back to 1943 when the Chesapeake Biological Laboratory and Maryland Tidewater Fisheries Commission collected data. In 1987, ASIS established nine water quality monitoring stations (5 in Chincoteague Bay and 4 in Sinepuxent Bay). At each station, 17 water quality parameters (water depth, water temperature, salinity, dissolved

oxygen, Secchi depth, pH, conductivity, Chlorophyll-*a*, total suspended solids, fecal coliform, orthophosphate dissolved, total phosphorus dissolved, total phosphorus, ammonium dissolved, nitrates and nitrites dissolved, total nitrogen, and total nitrogen dissolved) were generally collected monthly by park personnel from April through October (NPS 1991a). Currently, there are 18 stations that are sampled monthly year round for several water quality parameters including nitrate+nitrite, ammonium, phosphate, silica, total nitrogen (filtered), total phosphorus (filtered), total suspended solids, chlorophyll-*a*, *b*, and *c*, pheophytin-*a*, temperature, dissolved oxygen, salinity, specific conductance, pH, Secchi depth, light attenuation, and wind speed and direction (Kopp et al. 2002). Stations are located in both near-shore and mid-channel areas, with twelve of the stations in MD and six in VA. Station locations were chosen to insure that each embayment was monitored with importance given to areas of confluence of major tributaries, as well as areas with documented water quality problems, proximity to important living resources, habitats, and related and to historical monitoring sites. Additionally, there are two permanent automated monitoring stations where tide height, dissolved oxygen, total suspended solids, temperature, conductivity, and pH are recorded hourly. Results of data from 1987 to 1990 are presented in the ASIS Water Quality Monitoring Report (NPS 1991a) and results from 1990 to present are presented in several unpublished reports produced by ASIS staff.

Several water quality parameters are monitored by cooperative partnerships between agencies such as the MCBP and National Park Service at ASIS. The MD-DNR Resource Assessment Service coordinates the implementation of the monitoring through a Monitoring Subcommittee of the Scientific and Technical Advisory Committee (Kopp et al. 2002). Initiated in 1997, the Maryland Coastal Bays Volunteer Water Quality program monitors approximately 30 stations in the Maryland portion of the bays, coves, and tributaries adjacent to ASIS bimonthly from March through November and once per month December through February for a total of 21 sampling dates per year (MCBP 2003; MD-DNR 2000). MCBP monitors nitrate, nitrite, ammonia (at a limited number of sites), orthophosphate, pH, salinity, temperature, light attenuation, Secchi depth, and chlorophyll-*a* (MCBP 2003). Additionally, as part of the Coastal Bays Comprehensive Conservation and Management Plan for water quality, MD-DNR samples 45 stations monthly and 2 sites continuously from April through October (MD-DNR website). Data from the continuous stations include temperature, salinity, dissolved oxygen, Secchi depth, and pH (MD-DNR website). One weakness of the MCBP monitoring program is that a significant portion of ASIS estuarine habitat is not included because of the political boundary between Maryland and Virginia (Kopp et al. 2002).

The Maryland Department of the Environment (MDE) routinely monitors the sanitary quality of shellfish and tidal waters, including ocean sampling, and conducts sanitary surveys as part of the shellfish sanitation program. In 1998, the State's seasonal fish health and algal bloom monitoring program was expanded to St. Martin River, Trappe Creek, and Newport Bay (MD-DNR 2000). Additionally, the Wicomico County Health Department collects water quality data on the tidal waters through their surf zone monitoring program (MD-DNR 2000). ASIS has conducted a bathing beach water quality monitoring program at high-use ocean beaches in both Maryland and Virginia

since the early 1990's. Five stations are sampled weekly from May through September, and analyzed for the presence of *Enterococci* bacteria. At present, ASIS staff also collect ocean water samples within Assateague State Park for the Worcester County Health Department (C. Zimmerman, NPS, personal communication). In the 1990's, MDE also monitored fecal coliform within the Chincoteague-Sinepuxent Bay complex. MDE routinely monitored 43 stations monthly for the Shellfish Growing Water Certification Program. At 12 of the 43 stations water temperature, salinity, dissolved oxygen, and pH data were also collected.

Since 1972, MD-DNR has been monitoring estuarine finfish community structure within the MD coastal bays. Monthly (April-October) seine and twice-yearly (July and September) trawl surveys are conducted 18 and 20 fixed locations, respectively. Four of the sites are within the boundary of ASIS (C. Zimmerman, NPS, personal communication).

Submerged aquatic vegetation (SAV) has been surveyed in the coastal bays since 1986. Aerial overflights conducted during 1991-2001 have shown a 35% increase in SAV bed acreage (MCBP 2003; MD-DNR website). In 2002, MCBP provided the MD-DNR with an Implementation Grant to interpret 1950's aerial photographs to help determine historical submerged aquatic vegetation (SAV) acreage in the coastal bays (MCBP 2003).

Maryland DNR monitors macroalgae. Monitoring started in 1999 and the monitoring protocol is currently under review (Kopp et al. 2002). In 2001, over 600 stations in Maryland waters were sampled quarterly for species composition and biomass. The National Park Service and Maryland DNR also monitor harmful and/or nuisance algal blooms and initiated monitoring for *Aureococcus* in 1999 at 15 stations, and has monitored *Pfiesteria* since 1997 (MD-DNR website; C. Zimmerman, NPS, personal communication). A significant percentage of the annual sampling effort for *Pfiesteria* and *Aureococcus* is conducted by ASIS staff (C. Zimmerman, NPS, personal communication). In response to *Pfiesteria* outbreaks other parameters are also measured such as fish communities (species composition and abundance, external anomalies, histology and pathology), water quality (temperature, salinity, dissolved oxygen, pH, specific conductance, Secchi depth, nutrients, Chlorophyll a, total suspended solids, fluorometry, phytoplankton, water column urea), and sediments (grain size, particulate carbon, nitrogen, and phosphorus, presence or absence of *Pfiesteria* and related dinoflagellates).

ASIS has been systematically monitoring salt marsh vegetation since 1994 using a series of paired exclosures at four locations within the Maryland portion of the park. Part of this monitoring is to determine the influence of grazing (by wild ponies) on salt marsh communities (C. Zimmerman, NPS, personal communication). ASIS was selected as one of the Northeast Coastal and Barrier Network Units to implement long-term monitoring protocols for salt marsh vegetation and estuarine nekton (Roman et al. 2001; Raposa & Roman 2001) developed at Cape Cod National Seashore for the Long-Term Monitoring Program. In the summer of 2005, at least two salt marshes (probably Valentine's and

High Winds) will be selected and vegetation and nekton data will be collected. These data will serve as baseline data and it is hoped that the sites will be sampled in the future.

SETs (surface elevation tables) will be installed at ASIS in 2004-2005 (most likely at the northern tip of ASIS, Valentines Marsh, and High Winds Marsh) by the USGS (C. Roman, National Park Service, personal communication).

The National Park Service Water Resource Division and Servicewide Inventory and Monitoring Program conducted a baseline water quality data inventory and analysis of all surface waters (fresh, estuarine, and marine) for ASIS (NPS-WRD 1995a). There were 131 stations within the study area that yielded data, and 45 of these were located within the park's boundary. Generally data were available from 1969 through 1994. The technical report presents the results of surface-water-quality data retrievals for ASIS from five of the US EPA's national databases:

- Storage and Retrieval (STORET) database management system: Water quality parameter data, locations of sampling stations, descriptive elements about stations and parameters
- River Reach File (RF3): 1:100,000 scale geographical representation of surface waters (rivers, lakes, etc) with a unique identifier assigned to each surface water segment and connectivity information useful for routing and navigation.
- Industrial Facilities Discharge (IFD): Locations of industrial and municipal point source discharge facilities.
- Drinking Water Supplies (DRINKS): Locations of intake pipes for drinking water supplies.
- Stream Gages (GAGES): Locations of USGS and other discharge gages.

Provided within the ASIS technical report are: 1. complete inventory of all retrieved water quality parameter data, water quality stations, and the entities responsible for data collection; 2. descriptive statistics and appropriate graphical plots of water quality data characterizing annual and seasonal central tendencies and trends; 3. a comparison of ASIS's water quality data relevant to EPA and WRD water quality screening criteria; 4. an Inventory Data Evaluation and Analysis (IDEA) to determine what Servicewide Inventory and Monitoring Program Level I water quality parameters have been measured within the study area. Level I water quality parameters identified by the Servicewide Inventory and Monitoring program were: alkalinity, pH, conductivity, dissolved oxygen, and rapid bioassessment baseline for fish and macroinvertebrates. Optional case-by-case parameters included toxic elements, clarity/turbidity, nitrate/nitrogen, phosphate/phosphorus, chlorophyll, sulfates, and bacteria (NPS-WRD 1995a). The results of the ASIS water quality inventory found seven parameters that exceeded the EPA's criteria at least once within the study area. Dissolved oxygen and pH exceeded their respective EPA criteria for the protection of aquatic life. Copper, lead, and DDT exceeded their respective EPA acute criteria for the protection of marine aquatic life. Total coliform and fecal coliform concentrations exceeded the Water Resources Division screening limits for bathing water (NPS-WRD 1995a). The IDEA conducted for ASIS indicates that STORET data exist for every Level I parameter group within the study

area. However, much of the data were collected from a limited number of established monitoring stations (NPS-WRD 1995a). (NPS-WRD 1995a).

The EPA's National Coastal Assessment, also known as Coastal 2000, the Environmental Monitoring and Assessment Program (EMAP), and the Mid-Atlantic Integrated Assessment (MAIA) have monitored a variety of variables in Maryland's coastal bays (EPA EMAP website). Coastal 2000 sampling occurred in 2000, MAIA occurred in 1997 and 1998, and the Maryland and Delaware coastal Bays were sampled in 1990 to 1993 (Fig. 4-2). In 2000, Maryland Department of Natural Resources was awarded a 5 year grant from the US EPA as part of the National Coastal Assessment initiative (MD-DNR website) and 54 water quality, benthic community, sediment chemistry, and sediment toxicity stations and 20 fish stations were sampled in 2000 to 2001. In 2002, 124 water quality and benthic sites were monitored (MD-DNR website). Parameters that are monitored include dissolved oxygen, salinity, pH, temperature, water depth, photosynthetically active radiation, nitrogen species, phosphorus species, silicate concentration, river discharge, phytoplankton, water column chlorophyll-*a*, benthic community composition, benthic community abundance, fish community composition, fish community abundance, fish pathologies, fish parasitism, submerged aquatic vegetation abundance, macroalgae abundance, exotic species occurrence, metals and organics in sediments and tissues, sediment toxicity, total suspended solids, transmissivity, Secchi depth, total organic carbon, silt/clay percent, and habitat type (MD-DNR website; EPA EMAP website).

#### *Other Monitoring Data Sources*

ASIS has a National Atmospheric Deposition Program station (MD18) which has been in operation since 2000. This is a cooperative program between the NPS, MD-DNR, the Worcester County, and MCBP (C. Zimmerman, NPS, personal communication).

Land use and land cover data are available from NOAA Coastal Change Analysis Program and the Multi-Resolution Land Characteristics Consortium (1991 and 1992 imagery). The National Wetlands Inventory (NWI) data are available for the area. Detailed vegetation maps of the park, interpreted from 1993 aerial photography, are available from the park's GIS specialist.

Other land characterization data are available from the Worcester County Cooperative Extension Service and Worcester Soil Conservation District (agricultural land, animal population, and manure production estimates), and the Maryland Office of Agricultural Statistics (crop yields and acres), but these data are not yet compiled into a format conducive for tracking land use change (Kopp et al. 2002).

Table 4-1. Water Quality Attainment Status for State Designated Uses [305(b) waters] and Impaired Waters [303(d) listed] for Assateague Island National Seashore. Information is a summary from EPA Water Quality Inventory 305(b), EPA TMDL 303(d) Reports, Virginia Department of Environmental Quality 2002 303(d) Report, and Maryland's 2002 303(d) List. If a 305(b) ID is not listed then the corresponding 305(b) report for that segment of the water body could not be found. \* indicates a TMDL's has been established. VDH: Virginia Department of Health. "na" indicates information could not be found.

Waterbody	Listing Cycle	305 b Assessment Unit ID	303(d) List ID	Integrated List Category	Water Quality Attainment Status for State Designated Uses & Impairment
Assateague Channel/Sheepshead Creek	1998	Not Listed	VAT-D01E_SF_B	na	<i>Attainment status not found</i> <b>Water Impairments:</b> VDH Shellfish restriction <b>Source:</b> Non-point source
Chincoteague Bay	1998	MD-02130106-E-1_00 MD-02130106-E-1_01	MD-02130106-E-11	na	<b>Supports:</b> Fish, shellfish, and wildlife protection and propagation <b>Non-Support:</b> Portion of Bay (0.11 sq. mi.) does not support fish, shellfish, and wildlife protection and propagation <b>Shellfishing:</b> Portion of Bay (0.11 sq mi of Johnson Bay) is restricted due to fecal coliform from non-point runoff <b>Water Impairments:</b> nutrients, dissolved oxygen, organic enrichment, fecal coliform <b>Source:</b> Non-point and natural sources
Newport Bay*	2002	MD-02130105-E-1_00	MD-0024_02130105	na	<b>Supports:</b> Fish, shellfish, and wildlife protection and propagation <b>Water Impairments:</b> nutrients, dissolved oxygen, pathogens (fecal coliform), high pH <b>Source:</b> Point, non-point, and natural sources
Sinepuxent Bay	2000	MD-02130104-E_00	MD-02130104-E-11	na	<b>Supports:</b> Fish, shellfish, and wildlife protection and propagation <b>Shellfishing:</b> Portion of Bay (<0.01 sq mi) is restricted due to waste water discharge safety zone (not a water impairment)

					<b>Water Impairments:</b> nutrients, dissolved oxygen, fecal coliform <b>Source:</b> Non-point source
<b>Waterbody</b>	<b>Listing Cycle</b>	<b>305 b Assessment Unit ID</b>	<b>303(d) List ID</b>	<b>Integrated List Category</b>	<b>Water Quality Attainment Status for State Designated Uses &amp; Impairment</b>
Tom's Cove	1998	Not Listed	VAT-D01E_SF_K	na	<i>Attainment status not found</i> <b>Water Impairments:</b> VDH Shellfish restriction <b>Source:</b> Non-point source

Website addresses:

EPA Water Quality Inventory 305(b) website: <http://www.epa.gov/waters/305b/index.html>

EPA TMDL 303(d) Reports: <http://www.epa.gov/waters/tmdl/index.html>

Virginia Department of Environmental Quality 2002 303(d) Report: <http://www.deq.state.va.us/water/303d.html>

Maryland's 2002 303(d) List: <http://www.mde.state.md.us/Programs/WaterPrograms/TMDL/Maryland%20303%20dlist/index.asp>

Maryland's 2000 305(b) Report: [http://dnrweb.dnr.state.md.us/download/bays/MD2000\\_305b.pdf](http://dnrweb.dnr.state.md.us/download/bays/MD2000_305b.pdf)

Table 4-2. Vegetation classifications (to Virginia border), total hectares, and percent of total area for ASIS. Areas calculated from ASIS GIS coverages (based in 1993 aerial photography).

<b>Vegetation Description</b>	<b>hectares</b>	<b>Percent</b>
<b>Water</b>	106.7	3.0%
<b>Upland Vegetation</b>		
Naturally occurring Unvegetated areas	432.9	12.0%
Ammophila breviligulata - Panicum (amarum, amarulum)		
Herbaceous vegetation	121.8	3.4%
Built up areas (unvegetated)	23.3	0.6%
Dead vegetation	17.3	0.5%
Hudsonia tomentosa / Panicum (amarum, amarulum) Dwarf-shrubland	72.5	2.0%
Myrica (cerifera, pensylvanica) - Vaccinium corymbosum Shrubland	15.5	0.4%
Myrica cerifera / Hydrocotyle spp. Shrubland	507.6	14.1%
Myrica pensylvanica / Diodia teres Shrubland	191.7	5.3%
Myrica pensylvanica / Schizachyrium scoparium ssp. littorale - Eupatorium hyssopifolium Sparse Shrubland	84.9	2.4%
Pinus taeda / Hudsonia tomentosa Woodland	79.0	2.2%
Pinus taeda / Myrica cerifera / Osmunda regalis Forest		
Pinus taeda / Myrica cerifera / Vitis rotundifolia Forest	173.7	4.8%
Prunus serotina / Myrica cerifera / Smilax rotundifolia Forest	40.8	1.1%
Smilax glauca - Toxicodendron radicans Shrubland	7.2	0.2%
Undifferentiated dry grasses	53.7	1.5%
<b>Wetland Vegetation</b>		
Algae - (Mixed Fines Alliance)	13.0	0.4%
Baccharis halimifolia - Iva frutescens / Spartina patens Shrubland	215.3	6.0%
Juncus roemerianus Herbaceous vegetation	25.7	0.7%
Myrica cerifera - Baccharis halimifolia / Spartina patens Shrubland	95.1	2.6%
Panicum virgatum / Spartina patens Herbaceous vegetation	2.1	0.1%
Phragmites australis Herbaceous vegetation	13.1	0.4%
Salicornia spp. - Sarcocornia perennis - Spartina alterniflora Herbaceous vegetation	170.5	4.7%
Scirpus pungens / Fimbristylis castanea Herbaceous vegetation	8.4	0.2%
Spartina alterniflora / Ascophyllum nodosum Herbaceous vegetation	764.8	21.2%
Spartina patens - Distichlis spicata - Borrichia frutescens Herbaceous vegetation	339.0	9.4%
Spartina patens - Scirpus pungens - Solidago sempervirens (Upland) Herbaceous vegetation	28.3	0.8%
Typha angustifolia - Hibiscus moscheutos Herbaceous vegetation	0.4	< 0.1%

Table 4-3. Area (ha) and percent of wetland areas adjacent to 303(d) listed waterbodies. Only the estuarine and marine coastal embayments adjacent to ASIS are 303(d) listed and therefore only estuarine wetlands and aquatic beds are presumably impacted. Since the coastal embayments are contiguous 303(d) listed water bodies are not listed separately. Areas calculated from ASIS GIS coverages (1993 aerial photography).

Area	Waterbodies	Impairment	Forested wetlands	Non-Forested wetlands	Total Wetlands
ASIS	Chincoteague Bay and Sinepuxent Bay	nutrients, dissolved oxygen, organic enrichment, fecal coliform	0	1675.8 (100%)	1675.8
ASIS	Other wetlands	Not 303(d) listed	0	0	0

Table 4-4. Summary of long-term wetland and water quality monitoring programs within ASIS. MCBP: Maryland Coastal Bays; MD-DNR: Maryland Department of Natural Resources; NPS: National Park Service.

Monitoring Program	Time period	Agency	Data available
Atmospheric Deposition	2000 to present	NPS	Wet deposition ( $K^+$ , $Na^+$ , $Ca^+$ , $Mg^+$ , $NO_3^-$ , $Cl^-$ , $SO_4^{2-}$ , $PO_4^{3-}$ , $NH_4^+$ , $H^+$ )
Harmful and nuisance algal blooms	1997 to present	MD-DNR	<i>Aureococcus</i> (1999 to present) and <i>Pfiesteria</i> (1997 to present). Other parameters include fish communities (species composition and abundance, external anomalies, histology and pathology), water quality (temperature, salinity, dissolved oxygen, pH, specific conductance, Secchi depth, nutrients, Chlorophyll a, total suspended solids, fluorometry, phytoplankton, water column urea); and sediments (grain size, particulate carbon, nitrogen, and phosphorus, presence or absence of <i>Pfiesteria</i> and related dinoflagellates).
Macroalgae	1999 to present	MD-DNR	species composition and biomass
Submerge aquatic vegetation	1991 to present with historical data dating to 1930's	MD-DNR	Acreage of SAV beds based on aerial photography
Water quality	1997 to present	MCBP & MD-DNR	nitrate, nitrite, ammonia, orthophosphate, pH, salinity, temperature, light attenuation, Secchi depth, and chlorophyll- <i>a</i>
Water quality	1987 to present	NPS	water depth, water temperature, salinity, dissolved oxygen, Secchi depth, pH, conductivity, Chlorophyll- <i>a</i> , total suspended solids, fecal coliform, orthophosphate dissolved, total phosphorus dissolved, total phosphorus, ammonium dissolved, nitrates and nitrites dissolved, total nitrogen, and total nitrogen dissolved

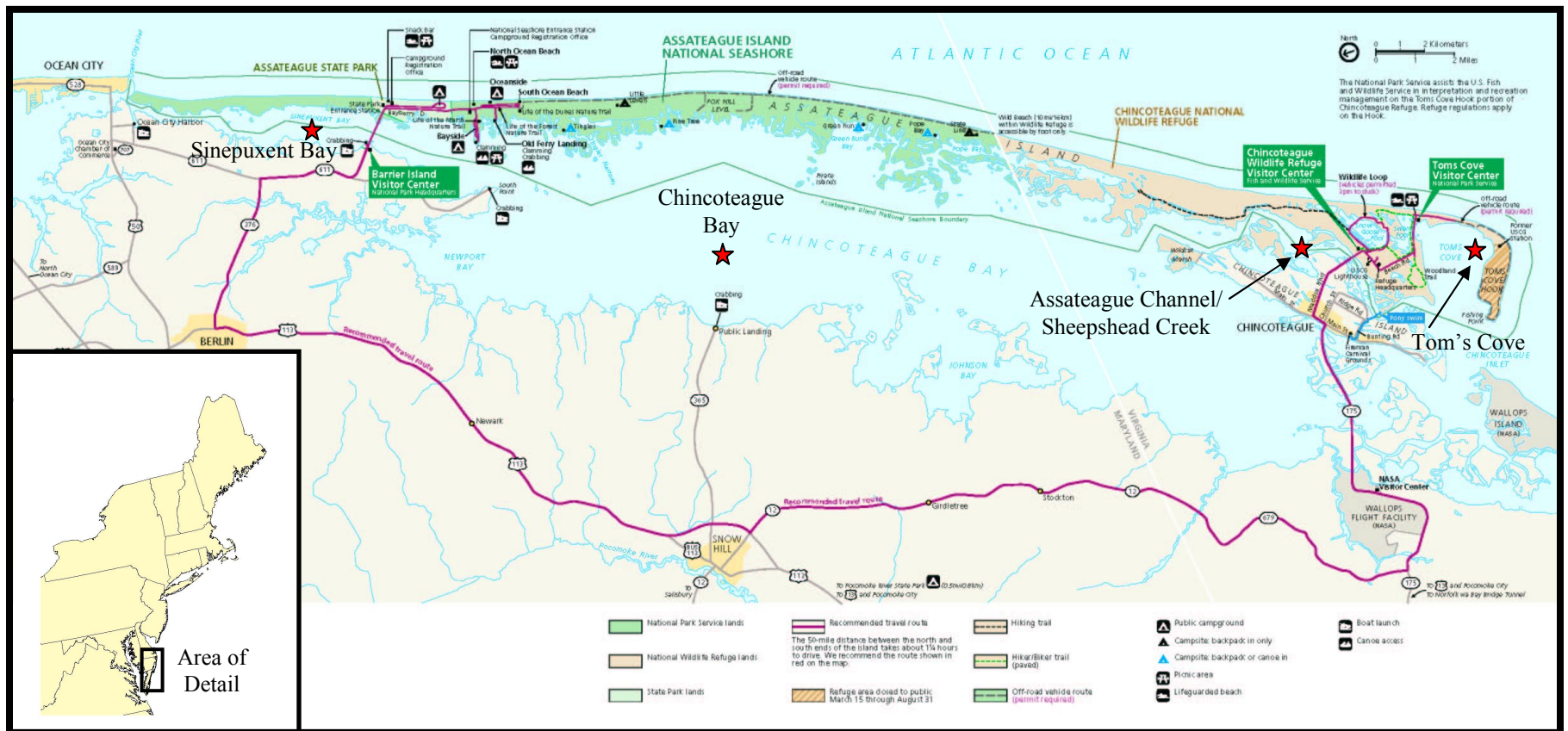
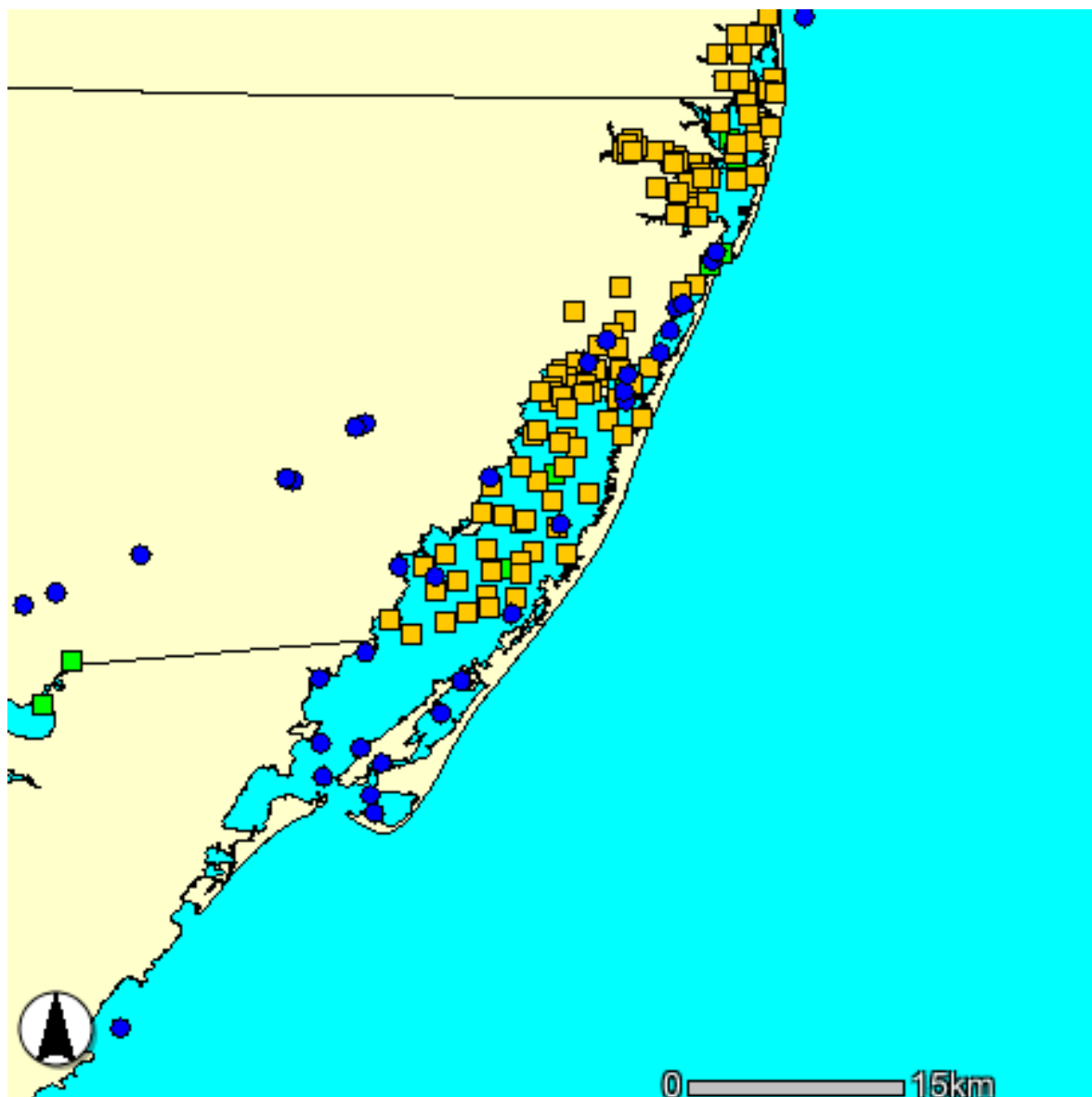


Figure 4-1. Map of Assateague Island National Seashore and surrounding waters. Stars indicate 303(d) listed waters.



Sampling Stations:

- Virginian Province (1990 to 1993)
- Mid Atlantic Integrated Assessment (1997 & 1998)
- Delaware – Maryland Bays (1993)

Figure 4-2. Map of sampling stations (and sampling years) for the Environmental Monitoring and Assessment Program (EMAP) near ASIS. Station data depicted above were produced by the U.S. Environmental Protection Agency through its EMAP Program, <http://www.epa.gov/emap>.

## **Chapter 5 - Boston Harbor Islands National Park Area**

### Water Quality

Boston Harbor Islands is a National Park Area that is unique within the park system. The federal law that established the park area made the National Park Service a nonland-owning participant in the 13 member Boston Harbor Islands Partnership (Flora 2002). Boston Harbor Islands National Park Area (BOHA) consists of over 607 ha of coastal woodlands, dunes, freshwater, estuarine, and marine wetlands, and sandy and rocky beaches scattered over 30 glacial drumlins (glacially-formed, asymmetrical, elongate masses of till formed into smooth shaped hills) comprising 34 islands, former islands, peninsulas, and bedrock outcrops within the 80 sq km of Boston Harbor (Flora 2002) (Fig. 5-1). The islands range in size from less than 0.5 ha to 101 ha. Wetlands are located on Calf Island (freshwater pond, salt marsh), Georges Island (salt marsh), Grape Island (salt marsh), Long Island (freshwater), Lovell Island (freshwater wetlands, salt marsh), Peddocks Island (salt marsh), Thompson Island (freshwater pond, freshwater wetlands, salt marsh), and Worlds End (freshwater wetlands, salt marsh, eelgrass beds) (Flora 2000).

305(b) and 303(d) water quality information are summarized in Table 5-1. Information is a summary from EPA Water Quality Inventory 305(b), EPA TMDL 303(d) Reports, the Boston Harbor 1999 Water Quality Assessment Report (MA-DEP 2002a), and the Massachusetts Year 2002 Integrated List of Waters (Commonwealth of Massachusetts 2002). The area surrounding Boston Harbor is highly urbanized and includes the City of Boston, Massachusetts and its large metropolitan area. The waters of Boston Harbor are primarily impaired by pathogens and priority organics, although turbidity, trash and debris, and suspended solids are also problems (Table 5-1). Combined sewer overflows (CSOs), urban and storm runoff, and municipal point sources are cause of the impairments, however for several smaller Bays within Boston Harbor (i.e. Hingham Bay, Hingham Harbor, Hull Bay, Quincy Bay) sources are unknown. The Massachusetts Department of Public Health (MA-DPH) has a fish consumption advisory for both freshwater and marine species due to mercury contamination (MA-DPH 2001). Due to this advisory all waters within the Charles watershed (watershed that includes Boston Harbor) cannot be listed as supporting or partially supporting fish consumption. Other designated uses that are impacted are primary and secondary contact recreation, and aesthetics (Table 5-1). Quincy Bay appears to be the most impaired Bay within the Boston Harbor system, having a non-support status for not only fish consumption, but also primary and secondary contact recreation (Table 5-1).

### Outstanding Resource Waters

The state of Massachusetts classified outstanding resource waters as Class A. There are no Class A waters within BOHA.

There are four Areas of Critical Environmental Concern (ACEC) adjacent or within close proximity to BOHA. Those areas include the Weir River ACEC, the Weymouth Back River ACEC, the Neponset River Estuary ACEC, and the Rumney Marshes ACEC. While the ACECs are located almost entirely outside of the boundary of the BOHA they are biologically connected and the habitats they provide are of great significance to the overall ecological health of the entire Boston Harbor area (Flora 2002).

Estuarine intertidal wetlands found at Worlds End comprise the northern edge of the Weir River ACEC as designated by the MA-DEM (Flora 2002). The Weir River ACEC is located adjacent to the boundaries of BOHA and is regionally significant both for its size and its importance in providing a relatively undisturbed marshland wildlife habitat. The Weir River ACEC contains a significant shellfish resource, supports an active anadromous fish run, and provides extensive nursery and feeding habitat for a wide variety of finfish including alewives (herring), smelt, flounder, bluefish, and striped bass. It also provides important habitat for over 100 species of migratory and indigenous birds and serves as an important food source for migratory waterfowl (MA-DEM 1986).

The Weymouth Back River ACEC comprises a natural area of approximately 385 ha in the midst of an urban/suburban environment (MA-DEM 1982). Approximately 73 ha of the Weymouth Back River ACEC are tidal waters flushing into Hingham Bay and support productive clam flats as well as nursery and feeding areas for finfish ecologically important to Boston Harbor. The ACEC also includes extensive salt marsh and salt pond habitats, and the lower portion of Herring Brook, Hingham's Fresh River, and several unnamed tributary streams which provide spawning sites for an annual anadromous fish (herring) run (MA-DEM 1982).

The Neponset River Estuary ACEC consists of 510 ha between Lower Mills Dam and the mouth of the Neponset River. The central resource features of the Neponset River Estuary ACEC are the Neponset River and portions of its tributaries, estuarine wetlands including salt marsh, floodplains, and fisheries and wildlife habitat (MA-DEM 1995). Open water, salt marsh and other estuarine wetland habitats comprise about 336 ha of this ACEC and support substantial soft-shell clam beds, valuable anadromous fishery habitat, spawning areas, and bird and wildlife habitat surrounded by an urbanized setting.

Most of the 1133 ha Rumney Marshes ACEC is located north of Boston Harbor principally within the Saugus River / Pines River estuary. However, the Belle Isle Marsh area of the Rumney Marshes ACEC empties into Winthrop Bay along the northern shore of Boston Harbor. The Belle Isle Marsh contains 111 ha of salt marsh, salt meadow, and tidal flats (MA-DEM 1988). It is publicly owned by the Metropolitan District Commission and the municipalities of Boston, Winthrop and Revere and provides both important ecological habitat and flood water storage (MA-DEM 1988).

### Wetland Area

Approximately 85 ha of land area within BOHA are vegetated wetlands, composed of estuarine and marine emergent wetlands and aquatic beds, while there are 431.2 ha of

non-vegetated reefs and shoreline (Table 5-2) (Tiner et al. 2003). Approximately 96% (78 ha) of the wetlands area within BOHA are influenced by the waters of Boston Harbor and nearby other embayments (e.g. Dorchester Bay, Hingham Bay) (Table 5-3, Fig. 5-1). Fifty-five percent (46.8 ha) of the vegetated wetlands are estuarine (emergent vegetation and aquatic beds), while 41% (35.1 ha) are marine aquatic beds (Table 5-2). Palustrine wetlands comprise only 3.6% (3.1 ha) of the total vegetated wetlands, and are comprised of emergent wetlands (2.4 ha), forested wetlands (0.4 ha) and scrub-shrub wetlands (0.3 ha) (Table 5-2) (Tiner et al. 2003). These wetlands are found on Great Brewster Is., Long Is., Lovells Is., Middle Brewster Is., Thompson Is., and Worlds End (Tiner et al. 2003). The water quality of these freshwater wetlands is unknown (Table 5-3).

### Wetland and Water Quality Issues

#### *Estuarine and Marine*

In May of 2000 a scoping workshop was held to identify water resource concerns and issues for BOHA. Issues that were identified were (Flora 2002):

- Inadequacy of available baseline information for intertidal, subtidal and wetland resources, and coastal processes (erosion).
- Nearshore water quality issues such as the potential impact of marinas/mooring areas/commercial boat discharge, infrastructural impacts (septics, sewage disposal), the need for public health and recreation water quality monitoring, impacts of water quality on shellfish harvesting, and the need for additional spill contingency planning.
- Water supply and groundwater issues.

Water quality concerns for islands located within the Inner Harbor, Old Harbor, and Dorchester Bay/Neponset Estuary areas of Boston Harbor (Deer Island, Long Island, Moon Island, Spectacle Island, and Thompson Island) include CSOs, stormwater discharge, sediment contamination (especially within the Inner Harbor) (Flora 2000). Islands within the Quincy Bay/Nantasket Roads area of Boston Harbor include Gallops Island, Georges Island, Lovell Island, Hangman Island, Nixes Mate, Nut Island, Rainsford Island. Water quality in this area is generally good with the majority of pollution stemming from stormwater discharge, as there are no CSOs in Quincy Bay. Wollaston Beach in Quincy Bay has variable water quality for primary recreation (swimming) and the Bay has productive shellfish beds, although the shellfish require depuration prior to being brought to market (Flora 2000). Islands within the Hingham Bay group include Bumpkin Island, Button Island, Grape Island, Langlee Island, Peddocks Island, Raccoon Island, Ragged Island, Sarah Island, Sheep Island, Slate Island, and Worlds End peninsula. Hingham and Hull Bays are among the most unpolluted waters of Boston Harbor. The good water quality is largely due to the undeveloped nature of the watershed and the lack of large point sources of pollution. The most significant source of pollution entering these bays is from stormwater (Flora 2000). The Outer Harbor group of islands, referred to as the “Brewsters”, includes Calf Island, Great Brewster Island, Green Island, Little Calf Island, Little Brewster Island, Middle Brewster Island, Outer Brewster Island, Shag Rocks, and The Graves. In the past, the

Brewsters were sometimes influenced by effluent from MWRA's Deer Island Treatment Plant (DITP), however with the new outfall for DITP, which extends 15 km into Massachusetts Bay, the impact of effluent has been greatly reduced (Flora 2000; MWRA 2003).

For many years Boston Harbor was notorious for its polluted waters, its water quality and adjacent wetlands being heavily influenced by their close proximity to the urban and industrial activities of Boston, Charleston, and East Boston. These municipalities contain major metropolitan development as well as port facilities. Pollution inputs into Boston Harbor included the discharge of sewage treatment plant effluent, sanitary sewer overflow, stormwater runoff, and CSOs. In 1986, the Massachusetts Water Resource Authority (MWRA) began the Boston Harbor Project with the goal of decreasing waste water pollution inputs into Boston Harbor.

From 1986 to 1995 the MWRA upgraded disinfection and primary treatment and then added secondary treatment to improve the quality of waste water effluent. The MWRA also increased the enforcement of pretreatment industrial waste water which significantly reduced the amounts of metals and other pollutants in waste water discharge (Rex et al. 2002). Prior to 1998, poorly treated waste water was discharged from Nut Island and Deer Island treatment plants. In 1991, the discharge of sewage solids (sludge) after digestion and disinfection was terminated. In 1998 the Nut Island Treatment Plant was closed (its flow was re-routed to the improved DITP), and by 2000 up to 85% of sewage discharged from Deer Island was undergoing secondary treatment. As of 2000, the MWRA discharges from a new ocean outfall diffuser located in Massachusetts Bay, approximately 15 km from DITP in 32 m of water. The new sewage outfall transports cleaner effluent completely out of the harbor and into Massachusetts Bay for greater dilution, and as of 2002, no treatment plants are discharging directly into the harbor (Rex et al. 2002). The new outflow has removed a significant portion of pollution from entering the harbor, however a significant fraction of remaining pollution is entering the harbor from its tributary rivers (e.g. Charles, Mystic, and Chelsea Rivers) (Rex et al. 2002).

Bacteria counts (*Enterococcus* and fecal coliform) were high prior to 1998 around Deer Island, Nut Island and the sludge outfalls; as well as in the Inner Harbor, along the shoreline, and in the rivers entering Boston Harbor. From 1998 to 2000 bacterial water quality improved, as result of secondary treatment and updated disinfection at DITP, to the point where much of the Harbor could support primary recreation (swimming) (Rex et al. 2002). Sources of bacterial pollution (e.g. stormwater runoff, CSOs, boats) inputs into the harbor are now localized and primarily affect the harbor's shoreline and beaches, with "hot spots" of bacterial pollution persisting at the mouth of the Neponset River, southern Dorchester Bay, Inner Harbor, mouth of the Mystic River, and Wollaston Beach (Rex et al. 2002). Concurrent with the opening of the new outfall other water quality and environmental parameters have also improved (e.g. Secchi depth, nutrients, Chlorophyll-*a*, sediment contaminants, benthic and fish communities) (Rex et al. 2002).

### Monitoring Programs (Table 5-4)

#### *All Habitats and Waters*

The MWRA has implemented a monitoring program for Boston Harbor since 1992 to monitor chemical, physical, and biological parameters as part of the regulatory compliance for the new discharge outfall diffuser. Parameters that are monitored include waste water and effluent components, toxic contaminants, pathogens, nutrients, water chemistry, phytoplankton composition, productivity, sediments and geochemistry, benthic communities, and fish and shellfish pathology, and other parameters. Monitoring is concentrated around the outfall (Boston Harbor and Massachusetts Bay) with additional “farfield” sites (e.g. Cape Cod Bay, and Stellwagen Bank National Marine Sanctuary) serving as reference locations (MWRA 2003). In addition to the routine monitoring, there are special studies that include: sediment transport, benthic nutrient flux study, zooplankton study in Cape Cod Bay, water circulation and particulate fate modeling, remote sensing, floatable debris, and marine mammal observations (MWRA 2003).

BOHA selected to implement long-term monitoring protocols for salt marsh vegetation and estuarine nekton (Roman et al. 2001; Raposa & Roman 2001) developed at Cape Cod National Seashore for the Long-Term Monitoring Program. Monitoring was conducted during the summer of 2004 (James-Pirri, University of Rhode Island, unpublished data). Nekton were monitored in the marsh on Thompson Island, and vegetation was monitored in the marshes of Thompson and Calf Island. These data will serve as baseline data and it is hoped that these marshes will be sampled long-term.

The National Park Service Water Resource Division and Servicewide Inventory and Monitoring Program is currently conducting a baseline water quality data inventory and analysis of all surface waters (fresh, estuarine, and marine) for BOHA (NPS-WRD website).

The EPA’s National Coastal Assessment, also known as Coastal 2000, and the Environmental Monitoring and Assessment Program (EMAP) monitor a variety of variables throughout Boston Harbor, parts of Massachusetts Bay, and Cape Cod Bay (Fig. 5-2). In Massachusetts, the EPA has teamed with the Massachusetts Office of Coastal Zone Management (MA-CZM), the Massachusetts Department of Fisheries, and the University of Massachusetts to monitor coastal water quality, sediment quality, and fish and benthic community structure, and fish pathology (Flora 2000; EPA EMAP website). A station is located in Hull Bay (Fig. 5-2). Specific parameters that are monitored include (Coastal 2000):

- Water quality: dissolved oxygen, salinity, temperature, depth, pH, nutrients, chlorophyll
- Sediment quality: grain size, total organic carbon, sediment chemistry, benthic community structure, sediment toxicity
- Biota: benthic community structure, fish community structure, fish external pathology, fish tissue analyses

The USGS maintains a National Water Information System (NWIS) water quality website, NWISweb Data for the Nation, where realtime data and archived data on surface water flow and levels in streams, lakes, springs, groundwater well levels, and water quality data from approximately 1.5 million stations nationwide can be queried (USGS 2004). USGS streamgaging stations are located at Old Swamp River at South Weymouth (near Hingham Bay), Muddy River at Brookline, and Mother Brook at Dedham, MA (near Dorchester Bay) (USGS NWIS website).

#### *Other Monitoring Data Sources*

The closest NADP (National Atmospheric Deposition Program) site is located in Middlesex, MA (station # MA13), which has been in operation since 1982.

GIS wetland data are available for BOHA from the National Wetlands Inventory (NWI). Original NWI maps were based on aerial photography (1:80,000) from the 1970's and maps were updated in the mid-1980's (1:58,000 aerial photography). In 2001, the National Park Service provided funds to the US Fish and Wildlife Service to update the NWI maps of BOHA based on 1995 color infrared at 1:40,000 aerial photography (Tiner et al. 2003). These GIS maps were completed in 2003 and will soon be available via the NWI website (Tiner et al. 2003).

Table 5-1. Water Quality Attainment Status for State Designated Uses [305(b) waters] and Impaired Waters [303(d) listed] for Boston Harbor Islands National Park Area. Information is a summary from EPA Water Quality Inventory 305(b), EPA TMDL 303(d) Reports, the Boston Harbor 1999 Water Quality Assessment Report (MA-DEP 2002a) (most current information), and the Massachusetts Year 2002 Integrated List of Waters (Commonwealth of Massachusetts 2002) (most current information). None of these water bodies had TMDL's reported to EPA by Massachusetts.

Waterbody	Listing Cycle	305 b Assessment Unit ID	303(d) List ID	Integrated List Category & Class	Water Quality Attainment Status for State Designated Uses & Impairment
Boston Harbor (includes President Roads and Nantasket Roads)	2002	MA70-01_00	MA70-01	5, SB	<b>Fish consumption advisory</b> <b>Supports:</b> aquatic life use, primary contact recreation, secondary contact recreation, aesthetics <b>Non-Support:</b> fish consumption <b>Water Impairment:</b> priority organics, pathogens, <b>Source:</b> unknown
Dorchester Bay (mouth of Neponset River to Head Is & N Thompson Is to Chapel Rocks)	2002	MA70-03_00	MA70-03	5, SB	<b>Fish consumption advisory</b> <b>Supports:</b> aquatic life use <b>Non-Support:</b> fish consumption <b>Partial Support:</b> primary contact recreation, secondary contact recreation, aesthetics <b>Water Impairment:</b> priority organics, pathogens, turbidity, suspended solids, trash and debris <b>Source:</b> combined sewer overflow
Hingham Bay (vicinity of Nut Island Treatment Plant)	2002	MA70-06_00	MA70-06	5, SB	<b>Fish consumption advisory</b> <b>Supports:</b> aquatic life use, primary contact recreation, secondary contact recreation, aesthetics <b>Not Assessed:</b> fish consumption <b>Water Impairment:</b> pathogens <b>Source:</b> none listed

Waterbody	Listing Cycle	305 b Assessment Unit ID	303(d) List ID	Integrated List Category & Class	Water Quality Attainment Status for State Designated Uses & Impairment
Hingham Bay (includes areas between Peddocks Is to Windmill Pt, to Bumpkin Is, Bumpkin Is to Sunset Pt to Worlds End; Worlds End to Crow Pt ; Beach In to Lower Neck to mouth of Weymouth River)	2002	MA70-07_00	MA70-07	5, SB	<b>Fish consumption advisory</b> <b>Fully Supports:</b> aquatic life use, primary contact recreation, secondary contact recreation, aesthetics <b>Not Assessed:</b> fish consumption <b>Water Impairment:</b> pathogens <b>Source:</b> none listed
Hingham Harbor (Hingham Harbor inside a line from Crows Pt to Worlds End)	2002	MA70-08_00	MA70-08	5, SB	<b>Fish consumption advisory</b> <b>Not Assessed:</b> aquatic life use, fish consumption, primary contact recreation, secondary contact recreation, aesthetics <b>Water Impairment:</b> pathogens <b>Source:</b> none listed
Hull Bay (E of a line from Windmill Pt to Bumpkin Is, and from Bumpkin Is to Sunset Pt)	2002	MA70-09_00	MA70-09	5, SB	<b>Fish consumption advisory</b> <b>Not Assessed:</b> aquatic life use, fish consumption, primary contact recreation, secondary contact recreation, aesthetics <b>Water Impairment:</b> pathogens <b>Source:</b> none listed
Quincy Bay (from Broomfield St. near Wallaston Yacht Club, N to buoy C"1", SE to Lord's Pt on the N shore of Hough's neck)	2002	MA70-04_00	MA70-04	5, SB	<b>Fish consumption advisory</b> <b>Supports:</b> aquatic life use, primary contact recreation, secondary contact recreation, aesthetics <b>Non-Support:</b> fish consumption <b>Water Impairment:</b> priority organics, pathogens <b>Source:</b> unknown

Waterbody	Listing Cycle	305 b Assessment Unit ID	303(d) List ID	Integrated List Category & Class	Water Quality Attainment Status for State Designated Uses & Impairment
Quincy Bay ( <i>N of class SA waters to Moon Head and Nut Is</i> )	2002	MA70-05_00	MA70-05	5, SB	<b>Fish consumption advisory</b> <b>Supports:</b> aquatic life use <b>Non-Support:</b> fish consumption, primary contact recreation, secondary contact recreation <b>Not Assessed:</b> aesthetics <b>Water Impairment:</b> priority organics, pathogens <b>Source:</b> urban runoff/storm sewers, municipal point source
Winthrop Bay ( <i>From tidal flats at Coleridge St, East Boston to a line between Logan International Airport and Pt. Shirley</i> )	2002	MA70-10_00	MA70-10	5, SB	<b>Fish consumption advisory</b> <b>Supports:</b> aquatic life use, aesthetics <b>Partial Support:</b> shellfishing, primary contact recreation, secondary contact recreation <b>Non-Support:</b> shellfishing <b>Not Assessed:</b> fish consumption <b>Water Impairment:</b> pathogens <b>Source:</b> CSO, urban runoff/storm sewers, unknown

**Fish consumption advisory:** In July 2001 the Massachusetts Department of Public Health (MDPH 2001) issued new statewide consumer advisories on fish (marine and freshwater) consumption due to mercury contamination. Because of the statewide advisory waters within the Charles watershed cannot be assessed as **Support** or **Partial Support** for the designated use category of *Fish Consumption*.

Website addresses:

EPA Water Quality Inventory 305(b) website: <http://www.epa.gov/waters/305b/index.html>

EPA TMDL 303(d) Reports: <http://www.epa.gov/waters/tmdl/index.html>

Boston Harbor 1999 Water Quality Assessment Report: <http://www.state.ma.us/dep/brp/wm/wqassess.htm>

Table 5-2. Vegetation Classifications and total hectares of vegetation within BOHA based on updated NWI data (1995 aerial photography) from Tiner et al. 2003 (Table reproduced from Tiner et al. 2003).

<b>Ecological System</b>	<b>Aquatic Habitat</b>	<b>Total Hectares</b>	<b>Percent of Wetland area</b>
<b>Estuarine</b>			
	Aquatic Bed (vegetated)	13.7	2.7
	Emergent Wetland (vegetated)	33.1	6.4
	Mussel Reef Bed (nonvegetated)	24.4	4.7
	Rocky Shore (nonvegetated)	19.5	3.8
	Unconsolidated Shore (nonvegetated)	300.1	58.1
<b>Marine</b>			
	Aquatic Bed (vegetated)	35.1	6.8
	Mussel Reef Bed (nonvegetated)	10.7	2.1
	Rocky Shore (nonvegetated)	14.2	2.8
	Unconsolidated Shore (nonvegetated)	53.0	10.3
<b>Palustrine</b>			
	Emergent Wetland (vegetated)	2.4	0.5
	Forested Wetland (vegetated)	0.4	0.1
	Scrub-shrub Wetland (vegetated)	0.3	0.1
	Unconsolidated bottom (nonvegetated)	5.3	1.0
	Unconsolidated Shore (nonvegetated)	4.0	0.8

Table 5-3. Total hectares of vegetated wetlands (including aquatic beds) within BOHA that are adjacent to 303(d) listed waterbodies. Note: “Other wetlands” are all Palustrine (emergent, forested, and scrub-shrub) wetlands. Table modified from Tiner et al. 2003.

<b>Island</b>	<b>Impairment</b>	<b>Forested wetlands</b>	<b>Non-forested Wetlands</b>	<b>Total wetlands</b>
Button Is. (Hingham Harbor)	Pathogens	0	0.6 (0.7%)	0.6
Calf Is. (Boston Harbor)	Priority organics, pathogens	0	0.7 (0.9%)	0.7
Deer Is. (Boston Harbor)	Priority organics, pathogens	0	2.3 (2.8%)	2.3
Gallops Is. (Boston Harbor)	Priority organics, pathogens	0	0.5 (0.6%)	0.5
Grape Is. (Hingham Bay)	Pathogens	0	4.0 (4.9%)	4.0
Great Brewster (Boston Harbor)	Priority organics, pathogens	0	2.4 (3.0%)	2.4
Green Is. (Boston Harbor)	Priority organics, pathogens	0	5.5 (6.8%)	5.5
Hangman Is. (Quincy Bay)	Priority organics, pathogens	0	1.0 (1.2%)	1.0
Little Calf Is. (Boston Harbor)	Priority organics, pathogens	0	1.9 (2.3%)	1.9
Long Is. (Boston Harbor)	Priority organics, pathogens	0	0	0
Lovells Is. (Boston Harbor)	Priority organics, pathogens	0	4.3 (5.3%)	4.3
Middle Brewster Is. (Boston Harbor)	Priority organics, pathogens	0	2.6 (3.2%)	2.6
Moon Is. (Boston Harbor & Quincy Bay)	Priority organics, pathogens	0	0.7 (0.9%)	0.6
Outer Brewster (Boston Harbor)	Priority organics, pathogens	0	4.5 (5.5%)	4.5
Peddocks Is. (Boston harbor & Hingham Bay)	Priority organics, pathogens	0	7.7 (9.5%)	7.7
Raccoon Is. (Hingham Bay)	Pathogens	0	2.1 (2.6%)	2.4
Ragged Is. (Hingham Harbor)	Pathogens	0	0.2 (0.2%)	0.2
Rainsford Is. (Boston Harbor)	Priority organics, pathogens	0	0.9 (1.1%)	0.9
Sarah Is. (Hingham Harbor)	Pathogens	0	3.3 (4.1%)	3.3
Shag Rocks (Boston Harbor)	Priority organics, pathogens	0	3.3 (4.1%)	3.3
Sheep Is. (Hingham Bay)	Pathogens	0	2.1 (2.6%)	2.1
Slate Is. (Hingham Bay)	Pathogens	0	5.6 (6.9%)	5.6
Snake Is. (Winthrop Bay)	Pathogens	0	7.5 (9.2%)	7.5
The Graves (Boston Harbor)	Priority organics, pathogens	0	1.5 (1.8%)	1.5
Thompson Is. (Boston harbor & Dorchester Bay)	Priority organics, pathogens, turbidity, suspended solids, trash & debris	0	7.9 (9.7%)	7.9
Worlds End (Hingham Harbor)	Pathogens	0	4.9 (6.0%)	4.9
Other wetlands (Great Brewster, Long, Lovells, Middle Brewster, Thompson, Worlds End)	Not 303d listed	0.4 (0.5%)	2.7 (3.3%)	3.1

Table 5-4. Summary of long-term wetland and water quality monitoring programs within BOHA. MWRA: Massachusetts Water Resource Authority

<b>Monitoring Program</b>	<b>Time period</b>	<b>Agency</b>	<b>Data available</b>
Water quality	1992 to present	MWRA	Waste water and effluent components, toxic contaminants, pathogens, nutrients, water chemistry, phytoplankton composition, productivity, sediments and geochemistry, benthic communities, and fish and shellfish pathology

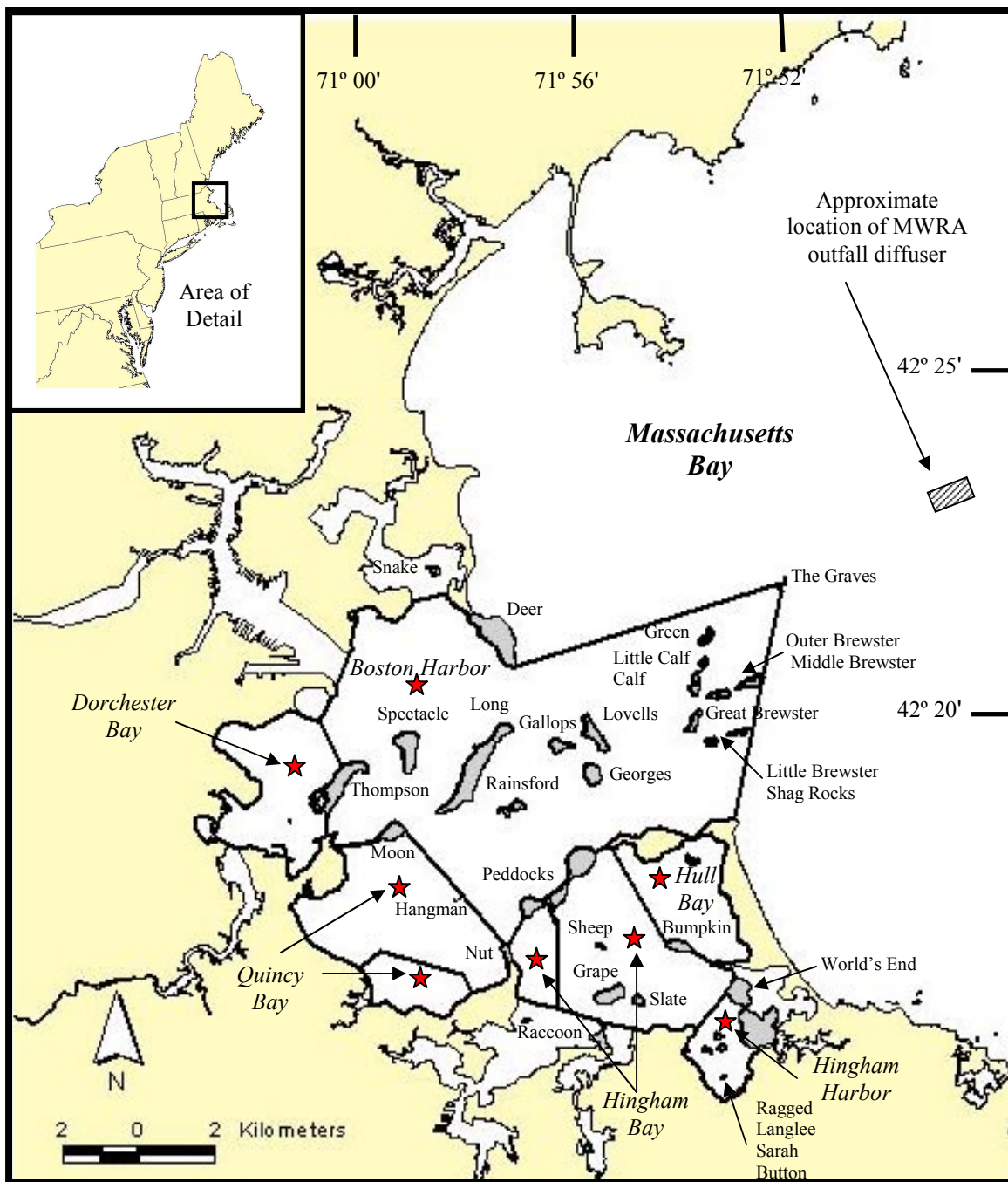


Figure 5-1. Map of Boston Harbor Islands National Park Area. Shaded areas indicate Park lands. Stars indicate 303(d) listed waters. Delineation of bays for 303(d) assessment courtesy of MA-DEP.

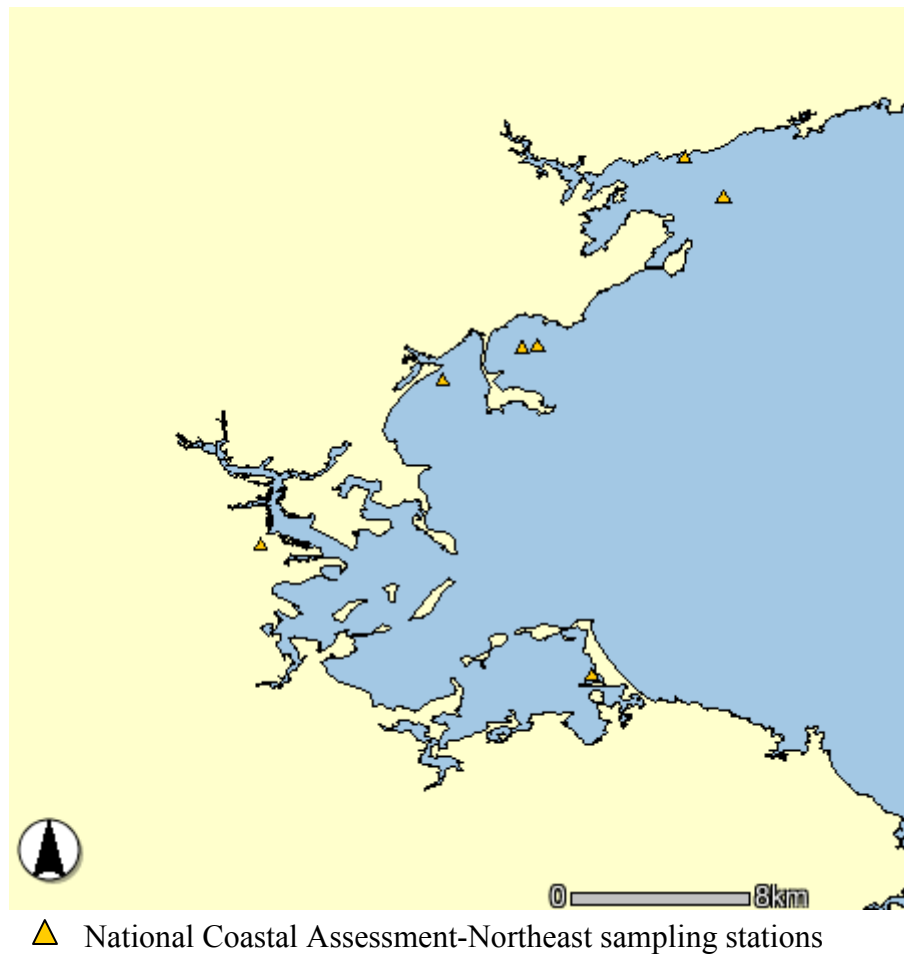


Figure 5-2. Map of sampling stations for the Environmental Monitoring and Assessment Program (EMAP) near BOHA. Stations were sampled in 2000. Station data depicted above were produced by the Environmental Protection Agency through its EMAP Program, <http://www.epa.gov/emap>.

## Chapter 6 - Cape Cod National Seashore

### Water Quality

Cape Cod National Seashore (CACO) comprises 17,646 ha of shoreline and upland landscape features, on outer Cape Cod (Fig 6-1). CACO is unusual within the National Park System in that it was established after the area had been settled for more than 300 years; therefore the opportunity to set aside wilderness or to assume responsibility for a large private holding was not an option. While 59% of the land is owned by the National Park Service, more than 30% of land within its boundaries is under the jurisdiction of other public entities, and nearly 4% is privately owned (Godfrey et al. 1999). Surface water resources within CACO include kettle ponds, seasonally-flooded wetlands, bogs, freshwater marshes, and dune ponds (Fig. 6-1) (Godfrey et al. 1999). There are 20 permanently-flooded kettle ponds, and 55 documented seasonally-flooded wetlands (vernal ponds). Freshwater marshes are located in river drainages, pond shores, and wetlands that were once salt water, but are now fresh, due to placement of dikes and tide gates that prohibit the influence of tidal waters on the marshes. Restoration of tidal flow to some of these marshes has recently begun (Roman et al. 2001). Dune ponds are small, shallow depressions that form between dunes on barrier spits and extend below the water table, and are part of a larger wetlands complex that includes bogs, marshes, and floating peat islands. Salt water marsh estuaries are a primary natural resource feature of CACO, however almost all of the estuarine salt marshes within the Seashore have been altered by ditching, dikes, or tide gates (Godfrey et al. 1999).

305(b) and 303(d) water quality information are summarized in Table 6-1. Water quality information is a summary from EPA Water Quality Inventory 305(b), EPA TMDL 303(d) Reports, and the Cape Cod Watershed Water Quality Assessment Report (MA-DEP 2002b), and the Massachusetts Year 2002 Integrated List of Waters (Commonwealth of Massachusetts 2002). Only a few of the estuarine waters within the boundaries of CACO on the 303(d) list have been assessed, and only for a few uses such as primary and secondary contact recreation and shellfishing (Table 6-1). The other designated uses (e.g. aquatic life support, fish consumption, and aesthetics) have not been assessed. Many waters are only noted as having a fish consumption advisory in effect (Table 6-1) as the Massachusetts Department of Public Health (MA-DPH) has issued an advisory for both freshwater and marine species due to mercury contamination. Due to this advisory, all waters within the Cape Cod watershed (including those within CACO) cannot be assessed as supporting or partially supporting fish consumption. Portions of Wellfleet Harbor, its adjacent tributaries (Duck Creek, Herring River), the Pamet River, and Provincetown Harbor either partially support or do not support shellfishing due to pathogens. Recently, acidity and metals have been added as impairments for Herring River (John Portnoy, NPS, personal communication). There are no sources listed for these impairments. Six of the twenty freshwater ponds within CACO are listed as impaired (Table 6-1), however only Ryder Pond has been assessed for designated uses. Ryder Pond is impaired by nutrients, organic enrichment, and low dissolved oxygen from

unknown sources, and supports aquatic life support, and primary and secondary contact recreation, but other designated uses have not been assessed. The MA-DPH fish consumption advisory also applies to this waterbody as it does to the other freshwater ponds within CACO. It is likely that other ponds may be similarly impaired, however since many of the freshwaters within CACO have not yet been assessed there is no further information.

### Outstanding Resource Waters

Waters in and adjacent (within 1,000 feet seaward of mean low water) to Cape Cod National Seashore have been classified as Outstanding Resource Waters (ORW) by the Massachusetts Department of Environmental Protection (MA-DEP). The MA-DPH has issued an advisory for both freshwater and marine species due to mercury contamination. Due to this fish consumption advisory, some of the waterbodies listed as ORW by MA-DEP (by virtue of their location within or adjacent of CACO) are also covered by this advisory. Some waters within Wellfleet Harbor that are considered as ORW due to their proximity to CACO, also are listed by the Cape Cod Commission as having degraded water quality. These waters include Duck Creek, Drummer Cove, and upper portions of Hatches Harbor and Blackfish Creek, however additional data on flushing and residence time need to be collected to determine the amount of degradation (Cape Cod Commission 1998). Two of the waterbodies listed as ORW (Herring River and Herring Pond) are also listed on the 2002 303(d) list. Pleasant Bay and Wellfleet Harbor have been designated as Areas of Critical Environmental Concern (ACEC) by Massachusetts Department of Environmental Management. However, Wellfleet Harbor is also 303(d) listed due to pathogens and non-support of shellfishing in Area CCB (Cape Cod Bay) 10.0.

The following waters are considered to be ORW:

Waters in and adjacent (Area within 1,000 feet seaward of mean low water) to Cape Cod National Seashore have been classified as Outstanding Resource Waters (MA-DEP 2002b).

Herring River (Listing ID MA96-33): Designated as an Outstanding Resource Water (MA-DEP 2002b).

Herring Pond (Listing ID MA96-133): Designated as an Outstanding Resource Water, special designation Class B, Warm Water Fisheries (MA-DEP 2002b).

Pleasant Bay: approximately 9,050 acres, is designated as and Area of Critical Environmental Concern (ACEC) (MA-DEM 2002). Pleasant Bay possesses outstanding natural resources on a regional and statewide level, including well-preserved and largely unaltered barrier beaches and islands, approximately 1200 acres of saltmarsh, and thousands of acres of tidal flats, numerous fresh and saltwater ponds, and a significant estuarine habitat. The barrier beaches also provide storm damage prevention. Despite recent rapid growth and development in the area, most of the marshes and tidal flats of Pleasant Bay have not yet experienced

significant degradation. Because of this relatively unaltered state of the marshes, barrier beaches, and tidal flats, these areas can function at their maximum capacity as habitat areas, and nursery and spawning grounds. There are four anadromous fish runs and extensive shellfish beds within Pleasant Bay. Pleasant Bay is extremely important as a transitional area between two biogeographic provinces. As such, the biological communities of the Bay contain some species at their most northerly range and others at their most southerly range. This wealth of biodiversity and the sensitivity of the organisms living at the extent of their ranges requires greater protection for such a unique resource area (MA-DEM 2002).

Wellfleet Harbor: approximately 12,350 acres, is designated as and Area of Critical Environmental Concern (ACEC) (MA-DEM 2002). Wellfleet Harbor is characterized by well-preserved and largely unaltered barrier beaches, islands, fresh and salt marshes, tidal flats, salt ponds, rivers, bays, and tidal creeks. Because of their high quality, the marshes, tidal flats, and barrier beaches function at their maximum capacity as habitat areas, nursery and spawning areas, and, in the case of barrier beaches, for the purposes of storm damage prevention. Nearly all of the shoreline is subject to erosion and some parts are listed as "critical erosion" areas by the Massachusetts Coastal Zone Management Program. The productivity of Wellfleet Harbor is exceptional, particularly for shellfish. The relatively high quality tributaries and headwaters provide spawning sites for anadromous fishes. Over half of the area of the ACEC lies within the estimated habitat of state-listed rare wetland wildlife species. Portions of the Wellfleet Harbor have been designated by the Department of Environmental Management as containing visual landscapes and cultural resources that place it in the top 5% of all landscapes in the Commonwealth. Lesser known features such as the kettle ponds at the headwaters of the Herring River are unique to the area.

### Wetland Area

Nine percent (1,050 ha) of CACO lands are vegetated wetlands (forested and non-forested) (Table 6-2). There are approximately 129 ha of forested wetland and 921 ha of non-forested wetlands within the Park. Approximately 45% of wetlands within CACO are potentially influenced by impaired waterbodies (Table 6-3), however, the majority of the impairments are due to a Massachusetts Department of Public Health advisory for the consumption of fish due to mercury contamination. Wetlands areas that may potentially impacted by other impairments (pathogens, acidity, and metals) are those in association with the Herring River, Wellfleet Harbor, and Provincetown Harbor. The total wetland area influenced by these waterbodies is approximately 130 ha and is almost entirely non-forested wetlands (Table 6-3).

### Wetland and Water Quality Issues

#### *All Habitats and Waters*

Development, recreation, and public use affect both wetlands and water quality within CACO. Godfrey et al. (1999) identified six water resource areas of concern:

- Groundwater withdrawal impacts
- Water resource contamination from non-point pollution sources
- Confirmed and potential contamination sites
- Cultural impacts to pond water quality and biota
- Park infrastructure management
- Impacts from tidal restrictions

### *Freshwater*

Very little is known about the interdunal bogs and vernal ponds of CACO. Wetland mapping and classification are outdated, and the impacts of water level change have not been evaluated for these resources (Godfrey et al. 1999). Three primary groundwater withdrawal concerns face CACO. First, excessive ground water withdrawals can lower the local water table, potentially depleting pond, wetland, and vernal pool water levels. Second, large-scale, sustained pumping can decrease aquifer discharge, impacting streams and estuaries. Finally, under extreme cases, groundwater volume may be depleted to a point where salt water intrudes and contaminates the fresh groundwater (Godfrey et al. 1999). Contamination of water resources from septic systems, underground oil tanks, landfills, treatment plants, stormwater runoff, fertilizers, and atmospheric deposition are major threats to water quality on Cape Cod (Cape Cod Commission 1998; Godfrey et al. 1999).

Kettle ponds are a unique resource within CACO. Most of the kettle ponds are naturally clear (low phytoplankton biomass) and acidic with low pH-buffering capacity. These conditions make the ponds sensitive to anthropogenic loading of either nutrients (phosphorus or nitrogen) or mineral acids from acid deposition (Portnoy et al. 2001). Recreational use threatens the water quality of kettle ponds, and historic fisheries management (stocking and liming) have impacted the pond waters (Godfrey et al. 1999). Recreational use of the ponds causes soil erosion (from foot traffic), increases nutrient loading, and the trampling of rare plants (Portnoy et al. 2001; Godfrey et al. 1999). Management concerns of the kettle ponds center on human activities and land uses that can increase nutrient loading (residential waste water disposal, swimmer use, and shoreline erosion), and atmospheric inputs of acids and metals (Portnoy et al. 2001). The Pleasant Bay Resource Management Alliance (PBRMA) identified threats to freshwater ponds in the Pleasant Bay area as overloading of nutrients, erosion and sedimentation caused by road runoff, and recreation impacts (PBRMA 2003).

### *Estuarine and Marine*

There is growing concern that coastal marine water quality is deteriorating, as evidenced by debris washing up on beaches and by the closure of shellfish beds due to high concentrations of coliform bacteria in coastal waters (NPS 1998). Since the early 1900s intertidal and estuaries resources on Cape Cod have been greatly altered by ditch

drainage, diking, and road and railroad construction, turning brackish waters with a marine influence into freshwater wetlands and upland habitats (NPS 1998; Godfrey et al. 1999). Restoration of tidal flow has been proposed for these diked areas. Tidal flow to the Hatches Harbor Marsh was re-introduced in 1999 (Roman et al. 2001), and vegetation at this site has been monitored periodically (2000 and 2001) since 1997. Nekton has been monitored in 2000 and 2004. Tidal flow was recently restored to Pilgrim Lake, and monitoring is currently ongoing at this site. Research and discussion on restoration alternatives are continuing for Herring River (Godfrey et al. 1999).

#### Monitoring Programs (Table 6-4)

##### *All Habitats and Waters*

CACO was selected as the prototype monitoring park for the Northeast Coastal and Barrier Network. The USGS-Biological Resources Division, in collaboration with the NPS, has been responsible for designing and testing the prototype protocols. Protocols related to water quality and wetlands that have been completed are the Estuarine Nekton Protocol (Raposa and Roman 2001), Hydrology Protocol (McCobb and Weiskel 2002), Salt Marsh Vegetation (Roman et al. 2001), Contaminants in Coastal Ponds and Marshes (Quinn et al. 2001), and Pond Breeding Amphibians (Paton et al. 2003). A summary of available weather data are also available in the Summary of Meteorologic and Atmospheric Monitoring Protocols for Cape Cod National Seashore (Anonymous 2001). Protocols currently in development related to wetlands and water quality are: Estuarine Nutrient Enrichment, Freshwater Fish, Marsh Sedimentation and Sea Level, Sediment and Benthic Contaminants, Shoreline Change, Dune Slack Wetland Vegetation, Kettle Pond Vegetation, Kettle Pond Water Quality, and Vernal Wetland Vegetation. A variety of research has occurred within CACO in the development of these protocols and the results of these studies are detailed in the completed protocols. Completed protocols and summaries of protocols in development are available at the National Park Service's Inventory and Monitoring website:

<http://www1.nature.nps.gov/im/monitor/protocol/db.cfm>

As part of the protocol development extensive research and monitoring has been conducted throughout CACO. To monitor nutrients, sites were established throughout the Seashore to monitor groundwater input (using seepage chambers), macroalgae species composition and abundance, and water nitrate concentration. Numerous water quality monitoring stations have also been established throughout the Seashore and were sampled for inorganic nutrients, chlorophyll-*a*, temperature, and salinity on a monthly basis. Currently these data are being evaluated by scientists at the University of Rhode Island. Several Surface Elevation Tables (SETs) have been installed throughout CACO at Herring River Marsh, Nauset Marsh, and Hatches Harbor Marsh to monitor sediment accretion rates of these marshes. SETs are initially monitored by the USGS with the NPS responsible for long-term monitoring (C. Roman, NPS, personal communication). Vegetation and nekton monitoring have occurred within several marsh systems (Hatches Harbor, Herring River, Pilgrim Lake, East Marsh, Nauset Marsh, Pleasant Bay Marshes). Amphibian monitoring has been conducted in the development of the Amphibian

protocol.

### *Freshwater Monitoring*

The kettle ponds of CACO have been monitored for several years. Total phosphorus and chlorophyll-*a* are fragmentary prior to 1997 (Portnoy et al. 2001). Secchi transparency was the most frequently measured variable since the mid 1970's, although data for some ponds extend back to the 1950's. Currently Secchi depth and dissolved oxygen are measured biweekly from May through October for the ten most intensively monitored ponds [Duck, Dyer, Great (Truro), Great (Wellfleet), Gull, Herring, Long, Ryder, Snow, Spectacle]. Secchi depth is measured once in April and August for the remaining 10 ponds. Alkalinity and pH have consistently been collected quarterly since 1985. Other water quality parameters (e.g. temperature, conductivity, major cations and anions) have been monitored consistently (twice per month from May through October) since 1999, although fragmentary data exist prior to 1996 (Portnoy et al. 2001) (Table 6-4).

The Pleasant Bay Resource Management Alliance conducted a resource assessment of freshwater ponds within the Pleasant Bay Area of Critical Environmental Concern (ACEC). This assessment provided a "snapshot" profile that identified and documented the presence and distribution of rare, endangered, indigenous, and invasive species of plants and animals (including submerged and emergent species) within 100 feet of the waters edge (PBRMA 2003).

Ponds that were evaluated included:

- Chatham: Lover's Lake, Stillwater Pond, Mill Pond, Minister's Pond, and Fox Pond
- Orleans: Sarah's Pond, Crystal lake, Pilgrim Lake, Little Quanset Pond, Gould Pond, and Uncle Seth's Pond

CACO conducted an acid rain monitoring project, to monitor the water chemistry of the kettle ponds, from 1983 through 1993.

The National Park Service Water Resource Division and Servicewide Inventory and Monitoring Program conducted a baseline water quality data inventory and analysis of all surface waters (fresh, estuarine, and marine) for CACO (NPS-WRD 1995b). There were five stations within the study area, three stations were located within the park's boundary. The technical report presents the results of surface-water-quality data retrievals for CACO from five of the US EPA's national databases:

- Storage and Retrieval (STORET) database management system: Water quality parameter data, locations of sampling stations, descriptive elements about stations and parameters
- River Reach File (RF3): 1:100,000 scale geographical representation of surface waters (rivers, lakes, etc) with a unique identifier assigned to each surface water segment and connectivity information useful for routing and navigation.
- Industrial Facilities Discharge (IFD): Locations of industrial and municipal point source discharge facilities.

- Drinking Water Supplies (DRINKS): Locations of intake pipes for drinking water supplies.
- Stream Gages (GAGES): Locations of USGS and other discharge gages.

Provided within the CACO technical report are: 1. complete inventory of all retrieved water quality parameter data, water quality stations, and the entities responsible for data collection; 2. descriptive statistics and appropriate graphical plots of water quality data characterizing annual and seasonal central tendencies and trends; 3. a comparison of CACO's water quality data relevant to EPA and WRD water quality screening criteria; 4. an Inventory Data Evaluation and Analysis (IDEA) to determine what Servicewide Inventory and Monitoring Program Level I water quality parameters have been measured within the study area (NPS-WRD 1995b). Level I water quality parameters identified by the Servicewide Inventory and Monitoring program were: alkalinity, pH, conductivity, dissolved oxygen, and rapid bioassessment baseline for fish and macroinvertebrates. Optional case-by-case parameters included toxic elements, clarity/turbidity, nitrate/nitrogen, phosphate/phosphorus, chlorophyll, sulfates, and bacteria (NPS-WRD 1995b). The results of the CACO water quality criteria found that Chloride and pH exceeded their respective EPA acute or chronic criteria for the protection of freshwater aquatic life. Alkalinity was below the threshold used by the NPS Air Quality Division for determining potential sensitivity to acid deposition (buffering capacity) (NPS-WRD 1995b). The IDEA conducted for CACO indicates that no STORET data exist for dissolved oxygen, flow, phosphate/phosphorus, sulfate, bacteria, chlorophyll, or toxic element groups. Very little data were retrieved for alkalinity, pH, conductivity, water temperature, clarity/turbidity, and nitrogen (NPS-WRD 1995b).

#### *Estuarine and Marine Monitoring*

In 1999, the Pleasant Bay Resource Management Alliance designed the Pleasant Bay Citizens Water Quality Monitoring Program and developed a comprehensive Quality Assurance Project Plan (QAPP), which outlined program goals, monitoring and analysis procedures, and quality control procedures (PBRMA 2003). The QAPP received approval from the Massachusetts Department of Environmental Protection (MA-DEP). Monitoring was initiated in 2000 and presently water quality samples are collected from 16 stations located throughout the Bay. In 2002, an additional 5 stations were added to provide additional data to the Southeastern Massachusetts Embayment Restoration Program to assist with nutrient modeling of the Bay. Water quality samples are collected from 0.5 m and 1 m (where water depth allows) on pre-selected dates from June through September. Samples are analyzed at the School for Marine Science and Technology (SMAST) Laboratory at the University of Massachusetts-Dartmouth. Parameters that are measured include chlorophyll-*a*, pheophytin-*a*, ammonium, orthophosphate, nitrate + nitrite, dissolved inorganic nitrogen, particulate organic nitrogen, particulate organic carbon, salinity, dissolved oxygen, temperature, transparency, total water depth, and weather observations. To date they have 3 consecutive years of water quality data on the Bay (PBRMA 2003). Based on their data, they have identified several areas of Pleasant Bay that are experiencing eutrophic conditions due to high nutrient levels. A

comprehensive water quality analysis and report will be conducted after a minimum of 3-5 years of data have been collected (PBRMA 2003).

The Pleasant Bay Resource Management Alliance is currently undertaking an Intertidal Habitat and Sediment Assessment Study. This project is in its first phase of a comprehensive inventory and monitoring program for habitats within Pleasant Bay. This study will classify and evaluate intertidal habitats, inventory biota, and monitor the dynamics in light of environmental and human use factors (PBRMA 2003).

The distribution of eelgrass within Pleasant Bay was mapped by the MA-DEP in 1997 based on aerial photography taken in 1993 and 1994. MA-DEP is in the process of updating this study based on 2000 aerial photography, a full report and analysis is expected in the near future (PBRMA 2003).

Vegetation cover and nekton use have been monitored at Hatches Harbor Marsh to evaluate the progress of re-introduced tidal flow to the formerly diked marsh. Vegetation and nekton were monitored before tidal was re-introduced (1997) and at 1 to 3 year intervals after tidal flow was re-introduced (1999 to present) (Roman et al. 2001).

The US EPA's National Coastal Assessment, also known as Coastal 2000, and the Environmental Monitoring and Assessment Program (EMAP) monitor a variety of parameters within Cape Cod Bay in 2000 and along the southern side of Cape Cod from 1990 to 1993 (EPA EMAP website) (Fig 6-2). Specific parameters that are monitored include (Coastal 2000):

- Water quality: dissolved oxygen, salinity, temperature, depth, pH, nutrients, chlorophyll
- Sediment quality: grain size, total organic carbon, sediment chemistry, benthic community structure, sediment toxicity
- Biota: benthic community structure, fish community structure, fish external pathology, fish tissue analyses

#### *Other Monitoring Data Sources*

The National Atmospheric Deposition Program (NADP) has a station (MA01) located at North Atlantic Coastal Laboratory in Truro, MA. The NADP site has been in operation since 1981. In 2003, the measurement of mercury deposition was added to this monitoring site.

Landuse and land cover data are available from the NOAA Coastal Change Analysis Program, and national land cover data are available from the Multi-resolution Land Characteristics Consortium from 1991 and 1992 imagery. National Wetlands Inventory Data, based on aerial photographs taken between 1970 and 1990, are also available. The MASSGIS and Cape Cod Commission also have a variety of GIS datasets available for Cape Cod and park-specific GIS data (e.g. vegetation, hydrological) are available from CACO GIS specialist.

Table 6-1. Water Quality Attainment Status for State Designated Uses [305(b) waters] and Impaired Waters [303(d) listed] for Cape Cod National Seashore. Information is a summary from EPA Water Quality Inventory 305(b), EPA TMDL 303(d) Reports, and the Cape Cod Watershed Water Quality Assessment Report (MA-DEP 2002b) (most current information), and the Massachusetts Year 2002 Integrated List of Waters (Commonwealth of Massachusetts 2002) (most current information). None of these water bodies had TMDL's reported to EPA by Massachusetts. CCB: MA Department of Marine Fisheries (DMF) classification areas codes for Cape Cod Bay (CCB) shellfishing areas, Shellfish Status Report, July 2000.

Waterbody	Listing Cycle	305 b Assessment Unit ID	303(d) List ID	Integrated List Category & Class	Water Quality Attainment Status for State Designated Uses & Impairment
Chatham Harbor (lower Pleasant Bay) <i>(N tip of Strong Is to CACO, S tip of Strong Is to Allen Pt, including waters from Amos Pt SE to CACO)</i>	2002	MA96-10	MA96-10	2, SA	<b>Fish consumption advisory</b> <b>Support:</b> primary contact recreation, secondary contact recreation, shellfishing <b>Not Assessed:</b> aquatic life use, fish consumption, aesthetics <b>Water Impairments:</b> none <b>Source:</b> none listed
Clapps Pond	2002	MA96-035	MA96-035	3, B	<b>Fish consumption advisory</b> <b>Not Assessed:</b> aquatic life use, fish consumption, secondary contact recreation, aesthetics <b>Water Impairments:</b> not assessed <b>Source:</b> not assessed
Duck Creek <i>(Cannon Hill to Shirttail Pt)</i>	2002	MA96-32	MA96-32	5, SA	<b>Fish consumption advisory</b> <b>Support:</b> primary contact recreation, secondary contact recreation, shellfishing (area CCB13.0) <b>Partial Support:</b> shellfishing (area CCB13.2 & CCB13.3) <b>Non-Support:</b> shellfishing (area CCB13.1) <b>Not Assessed:</b> aquatic life use, fish consumption, aesthetics <b>Water Impairments:</b> pathogens <b>Source:</b> none listed

Waterbody	Listing Cycle	305 b Assessment Unit ID	303(d) List ID	Integrated List Category & Class	Water Quality Attainment Status for State Designated Uses & Impairment
Great Pond (Truro)	2002	MA96-114	MA96-114	3, B	<b>Fish consumption advisory</b> <b>Not Assessed:</b> aquatic life use, fish consumption, secondary contact recreation, aesthetics <b>Water Impairments:</b> not assessed <b>Source:</b> not assessed
Gull Pond	2002	MA96-123	MA96-123	3, B	<b>Fish consumption advisory</b> <b>Not Assessed:</b> aquatic life use, fish consumption, secondary contact recreation, aesthetics <b>Water Impairments:</b> not assessed <b>Source:</b> not assessed
Herring Pond (Eastham)	2002	MA96-133	MA96-133	3, B	<b>Fish consumption advisory</b> <b>Not Assessed:</b> aquatic life use, fish consumption, secondary contact recreation, aesthetics <b>Water Impairments:</b> not assessed <b>Source:</b> not assessed
Herring River (Griffin Is to Wellfleet Harbor)	2002	MA96-33	MA96-33	5, SA	<b>Fish consumption advisory</b> <b>Support:</b> primary contact recreation, secondary contact recreation <b>Partial Support:</b> shellfishing (areas CCB12.1 & CCB12.2) <b>Non-Support:</b> shellfishing (areas CCB12.4 & CCB12.5) <b>Not Assessed:</b> aquatic life use, fish consumption, aesthetics <b>Water Impairments:</b> pathogens, acidity*, metals* <b>Source:</b> none listed
Long Pond (Wellfleet)	2002	MA96-179	MA96-179	3, B	<b>Fish consumption advisory</b> <b>Not Assessed:</b> aquatic life use, fish consumption, secondary contact recreation, aesthetics <b>Water Impairments:</b> not assessed <b>Source:</b> not assessed

Waterbody	Listing Cycle	305 b Assessment Unit ID	303(d) List ID	Integrated List Category & Class	Water Quality Attainment Status for State Designated Uses & Impairment
Nauset Harbor ( <i>E from Woods Cove around S point of Stony Is, around S point of unnamed island in harbor to CACO</i> )	2002	MA96-28	MA96-28	2, SA	<b>Fish consumption advisory</b> <b>Support:</b> primary contact recreation, secondary contact recreation, shellfishing <b>Not Assessed:</b> aquatic life use, fish consumption, aesthetics <b>Water Impairments:</b> none <b>Source:</b> none listed
Pamet River ( <i>Rt 6 to mouth at Cape Cod Bay, including Pamet Harbor</i> )	2002	MA96-31	MA96-31	5, SA	<b>Fish consumption advisory</b> <b>Support:</b> primary contact recreation, secondary contact recreation <b>Partial Support:</b> shellfishing (areas CCB7.1 & CCB 7.2) <b>Non-Support:</b> shellfishing (areas CCB7.3) <b>Not Assessed:</b> aquatic life use, fish consumption, aesthetics <b>Water Impairments:</b> pathogens <b>Source:</b> none listed
Provincetown Harbor ( <i>NW from tip of Long Pt to Beach Pt beach</i> )	2002	MA96-29	MA96-29	5, SA	<b>Fish consumption advisory</b> <b>Support:</b> primary contact recreation, secondary contact recreation, shellfishing (areas: CCB4.0, CCB4.20, CCB5.0) <b>Partial Support:</b> shellfishing (areas CCB4.2, CCB4.4) <b>Non-Support:</b> shellfishing (areas CCB4.1, CCB4.3, CCB5.1) <b>Not Assessed:</b> aquatic life use, fish consumption, aesthetics <b>Water Impairments:</b> pathogens <b>Source:</b> none listed
Ryder Pond (Truro)	2002	MA96-268	MA96-268	5, B	<b>Fish consumption advisory</b> <b>Support:</b> aquatic life use, secondary contact recreation, aesthetics <b>Not Assessed:</b> fish consumption, primary contact recreation <b>Water Impairments:</b> nutrients, organic enrichment/low dissolved oxygen <b>Source:</b> none listed

Waterbody	Listing Cycle	305 b Assessment Unit ID	303(d) List ID	Integrated List Category & Class	Water Quality Attainment Status for State Designated Uses & Impairment
Wellfleet Harbor (waters north of an imaginary line drawn W from Jeremy Pt to Sunken Meadow, excluding Herring River, Duck Creek, & Blackfish Creek)	2002	MA96-34	MA96-34	5, SA	<b>Fish consumption advisory</b> <b>Support:</b> primary contact recreation (7.25 mi), secondary contact recreation (7.25 mi), shellfishing (areas CCB11.0, CCB13.0, CCB14.0) <b>Non-Support:</b> shellfishing (area CCB10.0) <b>Not Assessed:</b> aquatic life use, fish consumption, primary contact recreation (0.02 mi), secondary contact recreation (0.02 mi), aesthetics <b>Water Impairments:</b> pathogens <b>Source:</b> none listed

**Fish consumption advisory:** Estuaries and coastal embayments in the Cape Cod watershed have not yet been assessed for *Fish Consumption* use. However, in July 2001 the Massachusetts Department of Public Health (MDPH 2001) issued new statewide consumer advisories on fish (marine and freshwater) consumption due to mercury contamination. Currently there are no MDPH-issued fish consumption advisories for any estuaries or coastal embayments in the Cape Cod watershed, however, because of the statewide advisory waters within the Cape Cod watershed cannot be assessed as Support or Partial Support for the designated use category of *Fish Consumption*.

\* Herring River was submitted to EPA for acidity and metals from non-point source in 2003 (J. Portnoy, NPS, personal communication)

Note: Ryder pond was assessed in 1999 for a TMDL.

Website addresses:

EPA Water Quality Inventory 305(b) website: <http://www.epa.gov/waters/305b/index.html>

EPA TMDL 303(d) Reports: <http://www.epa.gov/waters/tmdl/index.html>

Cape Cod Watershed Water Quality Assessment Report <http://www.state.ma.us/dep/brp/wm/wqassess.htm>

Table 6-2. Vegetation classifications and total hectares of vegetation within CACO. Areas calculated from CACO GIS coverages.

<b>Classification</b>	<b>Total Hectares</b>	<b>Percent of Total Area</b>
Ponds and Lakes	424.8	3.5%
Upland Vegetation		
Barren	734.6	6.0%
Bayberry-beach Plum-black Cherry	717.2	5.9%
Beach grass	1366.6	11.2%
Bear oak	266.2	2.2%
Bearberry	230.2	1.9%
Beech	24.3	0.2%
Black and White Oak	1279.7	10.5%
Black locust	123.5	1.0%
Cultivated	0.2	<0.1%
Dead trees	0.7	<0.1%
Developed	657.0	5.4%
Hairgrass	66.9	0.6%
Huckleberry	4.2	<0.1%
Meadowsweet-goldenrod	29.3	0.2%
Mixed grass	242.5	2.0%
Pitch pine	3080.1	25.2%
Pitch pine-oak	1936.3	15.8%
Velvet grass	0.4	<0.1%
Unidentified	7.3	<0.1%
Forested Wetland		
Atlantic white cedar	4.3	<0.1%
Highbush blueberry-swamp azalea	63.1	0.5%
Red maple	61.9	0.5%
Non-forested Wetlands		
Cattail	192.0	1.6%
Cattail and reed	28.5	0.2%
Cordgrass	664.9	5.4%
Reed	35.7	0.3%

Table 6-3. Total hectares (and percent of wetland type) of wetlands adjacent to 303(d) listed waterbodies within CACO. Note: FCA indicates Fish Consumption Advisory (due to mercury contamination) is in effect. Areas calculated from CACO GIS coverages.

<b>Waterbody</b>	<b>Impairment</b>	<b>Forested Wetlands</b>	<b>Non-forested Wetlands</b>	<b>Total Wetlands</b>
Clapps Pond	FCA	14.0 (1.3%)	2.9 (0.3%)	16.9
Gull Pond	FCA	4.0 (0.4%)	0.0	4
Herring River	FCA, pathogens, acidity, metals	0.5 (0.1%)	34.7 (3.3%)	35.2
Chatham Harbor	FCA	0.0	20.7 (2.0%)	20.7
Provincetown Harbor	FCA, pathogens	0.0	66.7 (6.3%)	66.7
Nauset Harbor	FCA	15.0 (1.4%)	281.1 (26.8%)	296.1
Great Pond	FCA	0.0	0.0	0.0
Long Pond	FCA	0.0	0.0	0.0
Ryder Pond	FCA, nutrients, organic enrichment, low dissolved oxygen	0.0	0.0	0.0
Wellfleet Harbor	FCA, pathogens	0.0	28.1 (2.7%)	28.1
Other Wetlands	Not 303d listed	95.9 (9.1%)	486.9 (46.3%)	582.8

Table 6-4. Summary of long-term wetland and water quality monitoring programs within CACO. MA-DEP: Massachusetts Department of Environmental Protection; MDN: Mercury Deposition Program; NPS: National Park Service; PBRMA= Pleasant Bay Resource Management Alliance; NADP: National Atmospheric Deposition Program

Monitoring Program	Time period	Agency	Data available
Atmospheric Deposition	NADP: 1981 to present MDN: 2003 to present	NPS	Wet deposition ( $K^+$ , $Na^+$ , $Ca^+$ , $Mg^+$ , $NO_3^-$ , $Cl^-$ , $SO_4^{2-}$ , $PO_4^{3-}$ , $NH_4^+$ , $H^+$ ); Mercury deposition
Eelgrass (Pleasant Bay)	1993-1994, 2000	MA-DEP	Distribution of eelgrass based on aerial photography
Kettle Ponds	1950's to present (depending on parameter)	NPS	Secchi depth (1950's to present), pH and alkalinity (1985 to present), temperature, conductivity, dissolved oxygen, major cations and anions (1999 to present), water chemistry (1983-1993)
Nekton (fish and decapods) (Hatches Harbor)	1997 to present	NPS	Nekton (fish and decapods) community composition and abundance before (1997) and after tidal flow was restored (2000 and 2004).
Salt marsh vegetation (Hatches Harbor)	1997 to present	NPS	Vegetation cover estimates before (1997) and after tidal flow was restored (2000 and 2002).
Water Quality (Pleasant Bay)	2000 to present	PBRMA	Chlorophyll- <i>a</i> , pheophytin- <i>a</i> , ammonium, orthophosphate, nitrate + nitrite, dissolved inorganic nitrogen, particulate organic nitrogen, particulate organic carbon, salinity, dissolved oxygen, temperature, transparency, total water depth, and weather observations.



Figure 6-1. Map of Cape Cod National Seashore Area. Stars indicate 303(d) listed waters.

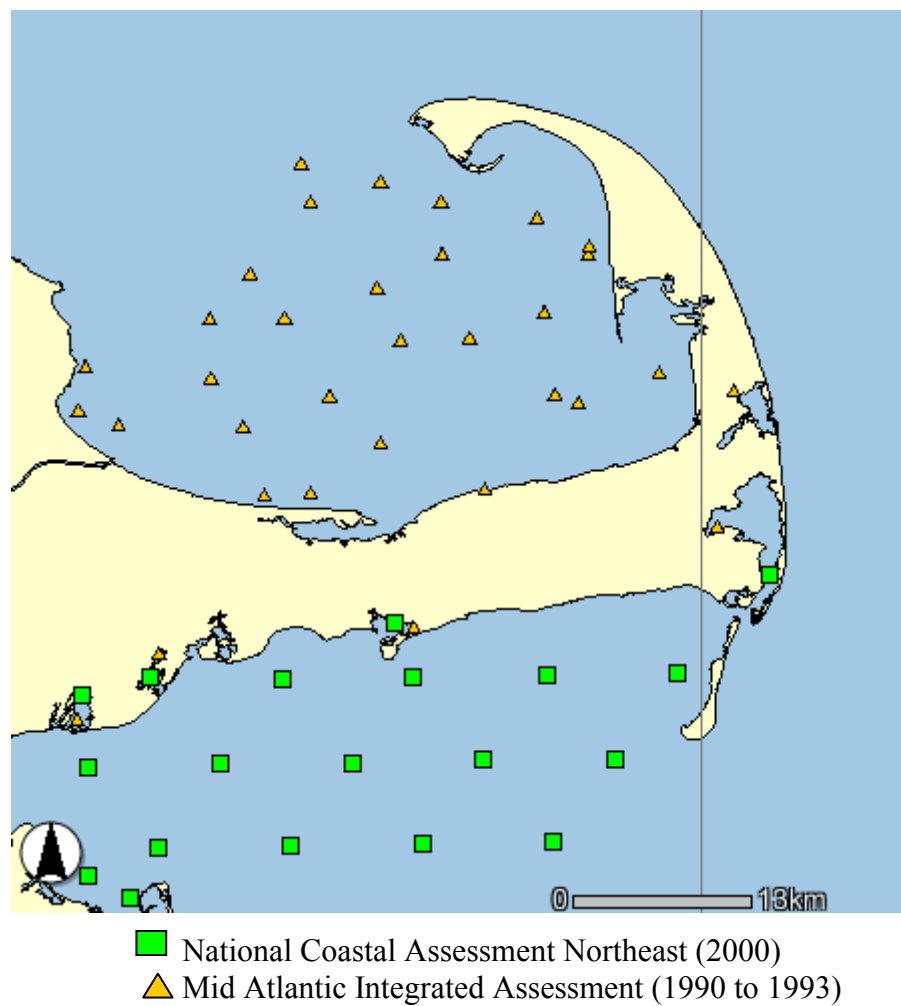


Figure 6-2. Map of sampling stations (and sampling years) for the Environmental Monitoring and Assessment Program (EMAP) near CACO. Station data depicted above were produced by the U.S. Environmental Protection Agency through its EMAP Program, <http://www.epa.gov/emap>.

## Chapter 7 - Colonial National Historical Park

### Water Quality

Colonial National Historical Park (COLO) is a 3,774 ha park that is bordered by the York River and James River estuaries in the coastal plain of Virginia (Fig. 7-1). The park encompasses Yorktown Battlefield, Colonial Williamsburg, Jamestown Island, and parcels of land adjacent to the Colonial Parkway. COLO administers two of the most historically significant sites in English North America. Jamestown, the first permanent English settlement in North America in 1607, is administered jointly with the Association for the Preservation of Virginia Antiquities (APAV), and Yorktown Battlefield, the final major battle of the American Revolutionary War in 1781. COLO is currently undertaking the Jamestown Project that will improve visitor experience at Jamestown Island (NPS 2003). Within the park there is a complex network of streams with substantial areas of salt and freshwater marshes intersects park lands (NPS 1994). Wetlands within COLO include forested freshwater communities, emergent freshwater communities, and emergent tidal communities, and cover approximately 27% of the park lands (NPS 1994). The park's estuarine wetlands, in particular Queen Creek and Back River system, are important nursery areas for a variety of fish species (Swihart and Spells 1992; Swihart and Spells 1987).

303(d) and 305(b) water quality information for COLO are summarized in Table 7-1. Information is a summary of EPA Water Quality Inventory 305(b), EPA TMDL 303(d) Reports, and 2002 Virginia Department of Environmental Quality (VA-DEQ) 303(d) and 305(b) Reports (VA-DEQ 2002a, 2002b). The most common impairments to water quality in COLO are pathogens (e.g. fecal coliform), Virginia Department of Health (VDH) shellfish restrictions, organic enrichment, and low dissolved oxygen. King and Queen Creek are probably the most impaired waters, judging by the number and type of impairments. These creeks are impaired by organic enrichment, low dissolved oxygen, pathogens, fecal coliform, sediment and siltation, and PCBs in fish tissue, sediments, and the water column (Table 7-1). Both creeks have a VDH shellfish restriction in effect. Sources of the impairments are not clear, but natural and non-point sources are implicated. The PCBs in fish tissues of King Creek may be related to the PCBs in the sediments of Queen Creek. Designated uses that are affected are aquatic life, shellfishing, primary contact recreation, and fish consumption. Powhatan Creek is impaired by fecal coliform, pathogens, and general benthic standard, affecting the designated uses of aquatic support, and primary contact recreation (Table 7-1). The sources of impairments are unknown. Mill Creek is impaired by fecal coliform, affecting primary contact recreation. Felgates Creek is impaired by pathogens from non-point sources and has a VDH restriction for shellfishing. Indian Field Creek also has a VDH shellfish restriction in effect. The James River is impaired by nutrients of an unknown source. The York River is impaired for the general benthic standard, organic enrichment, dissolved oxygen, and nutrients from unknown and natural sources (Table 7-1).

### Outstanding Resource Waters

Virginia classifies Outstanding Resource Waters as Significant Lakes. There are no Significant Lakes within COLO.

### Wetland Area

Total wetland area within the boundaries of COLO is 868 ha and compromises 27% of the vegetation within the park (Table 7-2). Seventy-one percent of the wetland areas are tidal wetlands. Overall, an estimated 45% of all wetland areas within COLO are impacted by 303(d) waters (Table 7-3). Sixty-three percent of the tidal wetlands are adjacent to 303(d) listed waters, whereas only 3% of forested wetlands are found near 303(d) waters. Impaired waterbodies that influence the highest percentage of wetlands within COLO are the James River (37%), Powhatan Creek (4%), and King Creek (2.8%) (Table 7-3).

### Wetland and Water Quality Issues

#### *All Habitats and Waters*

COLO lies within the coastal plain of Virginia with park lands having a hydrological link to the Chesapeake Bay. The park extends along either the York or James Rivers and numerous streams, creeks, and ponds flow through the park and feed into one of these two rivers. The unique geographic setting and layout of COLO means that few of the park's waters exist within systems wholly contained by the park's boundaries. Most of the water bodies in the park have portions of their upstream stretches outside of park boundaries. As a result, activities outside of the park influence water quality within the park. Potential sources of contaminants include industrial and municipal waste water discharges, stormwater runoff from developed areas, septic leachate, boats, and marinas (NPS 1994).

The overarching issue for all park water resources is the effective communication and coordination of park management objectives with local, state, and federal entities responsible for planning, regulation, and management of lands and waters contiguous to the park (NPS 1994). The main issues for COLO concerning water resources are groundwater and potential impacts from adjacent land use practices; shoreline change along rivers, creeks, streams, and drainages and the effective management of erosion and sediment impacts to these areas; the impact of water flow, groundwater withdrawals, mowing, and forestry practices on tidal and non-tidal wetlands.

Non-point source pollution resulting from erosion and sedimentation poses a threat to park water quality and natural resources. Park management has taken several actions within and outside the park to reduce erosion and sedimentation impacts to wetlands, streams, tidal rivers, and associated aquatic resources and changes in mowing practices have been implemented to alleviate these impacts (NPS 1994).

### *Freshwater*

COLO contains 9 Coastal Plain Depression Ponds or sinkhole ponds, a rare and threatened seasonal wetland community group. In 1998, the Virginia Department of Conservation and Recreation's Division of Natural Heritage (DCR-DNH) conducted a two-year interdisciplinary investigation into the ecology and biota of the sinkhole ponds (Van Alstine et al 2001). The ponds within COLO are part of a larger complex of Coastal Plain Depression Ponds known as the Grafton Ponds Complex. Ponds that have been surveyed in this complex outside COLO support seven species of rare plants and animals in addition to significant natural community occurrences (Rawinski 1997).

### *Estuarine and Marine*

Erosion is a significant process along the river shorelines of the park. Much of the erosion results from normal and storm induced wave activity, yet impacts from recreational use are also a concern (Rafkind et al. 1990). Severe erosion has been noted at specific points along the York and James River, especially Jamestown Island, the cliffs below the Yorktown Visitor Center (Hubbard 1989), and the shoreline fronting the Glass House at Jamestown Island. Shoreline recession threatens the culture resources of these areas and is responsible for the aerial reduction in intertidal wetland communities along Jamestown Island. It is unknown if this is due to erosion from wave action or sea level rise or both (NPS 1994).

### Monitoring Programs (Table 7-4)

#### *All Habitats and Waters*

As part of the Jamestown Project the NPS will fund a Long Term Monitoring Plan to inventory and monitor potential and known impacts to the biological and physical environment. For example, inventory data that would potentially include stormwater quantity and quality, surface water quality and nutrient, benthic data, wetland quality, and the effects boat traffic (NPS 2003).

#### *Freshwater Monitoring*

Currently, there is no water quality monitoring program at COLO (Kopp et al. 2002). COLO has initiated a process for developing a long-term surface water quality monitoring program (Project Statement COLO-N-601.503), however there are too few stations in or near COLO, and too few measured parameters, to adequately describe water quality within the Park (Kopp et al. 2002).

The USGS maintains a National Water Information System (NWIS) water quality website, NWISweb Data for the Nation, where realtime data and archived data on surface water flow and levels in streams, lakes, springs, groundwater well levels, and water quality data from approximately 1.5 million stations nationwide can be queried (USGS

2004). There is a continuous stream gaging station at Baptist Run at Rt 637 near Yorktown, VA (USGS 0204278995), that has been in operation since 2002. Historical water quality data (1980 to 1991) are available from a station on Beaverdam Creek near Yorktown, VA (USGS 02042790).

The National Park Service Water Resource Division and Servicewide Inventory and Monitoring Program conducted a baseline water quality data inventory and analysis of all surface waters (fresh, estuarine, and marine) for COLO (NPS-WRD 1994b). Water quality data were available for 116 stations within the study area, and thirteen of these were located within the park's boundary. No data were available for six of the stations within the park. The technical report presents the results of surface-water-quality data retrievals for COLO from five of the US EPA's national databases:

- Storage and Retrieval (STORET) database management system: Water quality parameter data, locations of sampling stations, descriptive elements about stations and parameters
- River Reach File (RF3): 1:100,000 scale geographical representation of surface waters (rivers, lakes, etc) with a unique identifier assigned to each surface water segment and connectivity information useful for routing and navigation.
- Industrial Facilities Discharge (IFD): Locations of industrial and municipal point source discharge facilities.
- Drinking Water Supplies (DRINKS): Locations of intake pipes for drinking water supplies.
- Stream Gages (GAGES): Locations of USGS and other discharge gages.

Provided within the COLO technical report are: 1. complete inventory of all retrieved water quality parameter data, water quality stations, and the entities responsible for data collection; 2. descriptive statistics and appropriate graphical plots of water quality data characterizing annual and seasonal central tendencies and trends; 3. a comparison of COLO's water quality data relevant to EPA and WRD water quality screening criteria; 4. an Inventory Data Evaluation and Analysis (IDEA) to determine what Servicewide Inventory and Monitoring Program Level I water quality parameters have been measured within the study area (NPS-WRD 1994b). Level I water quality parameters identified by the Servicewide Inventory and Monitoring program were: alkalinity, pH, conductivity, dissolved oxygen, and rapid bioassessment baseline for fish and macroinvertebrates. Optional case-by-case parameters included toxic elements, clarity/turbidity, nitrate/nitrogen, phosphate/phosphorus, chlorophyll, sulfates, and bacteria (NPS-WRD 1994b). The results of the COLO water quality criteria found 15 parameters that exceeded screening criteria at least once within the study area. Dissolved oxygen, pH, chloride, total residual chlorine, cadmium, copper, zinc, and endosulfan exceeded their respective EPA acute or chronic criteria for the water criteria. Nitrate, sulfate, cadmium, lead, and nickel, exceeded their respective EPA drinking water criteria. Indicator bacteria (total and fecal coliform) concentration and turbidity exceed the WRD screening limits for primary-body contact recreation and aquatic life (NPS-WRD 1994b).

The Izaak Walton League of America Virginia Save Our Streams Programs (IWLA VA SOS) conducted 4 sampling events for benthic macroinvertebrates at 3 stations within the York River in 2000 to 2002 (VA DEQ 2002).

### *Estuarine and Marine Monitoring*

In the summer of 2003 the USGS-BRD developed and tested operational monitoring protocols for estuarine nutrient monitoring at COLO as part of the development of vital signs monitoring within the Northeast Coastal and Barrier Network parks (Neckles et al. 2002). Monitoring variables include chlorophyll-*a*, dissolved oxygen concentration, attenuation of photosynthetically active radiation, temperature, and salinity.

COLO was selected as one of the Northeast Coastal and Barrier Network Units to implement long-term monitoring protocols for salt marsh vegetation and estuarine nekton (Roman et al. 2001; Raposa & Roman 2001) developed at Cape Cod National Seashore for the Long-Term Monitoring Program. In the summer of 2003, vegetation and nekton were sampled at two marshes (King Creek on the York River and Back River on Jamestown Island) (James-Pirri, University of Rhode Island, unpublished data). These data will serve as baseline data and it is hoped that these sites will be sampled long-term.

The Virginia Chesapeake National Estuarine Research Reserve (CBNERR-VA) is located across the York River at the Virginia Institute of Marine Science (VIMS). The CBNERR-VA collects continuous meteorological and weather monitoring and is interested in possibly expanding to include atmospheric deposition monitoring (Kopp et al. 2002). The CBNERR-VA also collects monthly discrete water quality (chlorophyll-*a*, Secchi depth, diffuse attenuation coefficient of PAR, ammonium, nitrate, nitrite, and phosphate) monitoring at a minimum of four stations along the lower York River since 1997 (Kopp et al. 2002). The reserve is planning to add additional nutrient parameters (particulate nitrogen and phosphorus, total dissolved nitrogen and phosphorus, particulate and dissolved organic carbon, and silica) in the near future. The same four stations (continuously automated sampling bouys) record temperature, salinity, turbidity, total suspended solids, dissolved oxygen and pH (Kopp et al. 2002).

The US EPA's Environmental Monitoring and Assessment Program (EMAP) and the Mid-Atlantic Integrated Assessment (MAIA) monitored a variety of parameters within the York and James Rivers in the 1990s (EPA EMAP website) (Fig. 7-2). Specific parameters that are monitored include (Coastal 2000):

- Water quality: dissolved oxygen, salinity, temperature, depth, pH, nutrients, chlorophyll
- Sediment quality: grain size, total organic carbon, sediment chemistry, benthic community structure, sediment toxicity
- Biota: benthic community structure, fish community structure, fish external pathology, fish tissue analyses

Chesapeake Bay Water Quality and Habitat Monitoring Program assesses trends in water quality and living resources throughout the Virginia portion of the Bay. Water quality is

monitored at 38 stations along the Rappahannock, York, and James Rivers (VA DEQ 2002).

Monitoring of several biotic and physical parameters is conducted by the Virginia Institute of Marine Science (VIMS). VIMS conducts annual mapping of the distribution and biomass of submerged aquatic vegetation (Kopp et al. 2002). The VIMS Juvenile Fish and Blue Crab Survey, initiated in 1995, currently samples 60 stations monthly (Kopp et al. 2002). The VIMS “Shoal Run” has a station near COLO (Yorktown) and measures dissolved inorganic nitrogen and phosphorus, total suspended solids, chlorophyll-*a*, and diffuse attenuation coefficient of PAR (Kopp et al. 2002).

There is also a remote sensing program for chlorophyll-*a* throughout the Chesapeake Bay using Ocean Data Acquisition System satellite sensors since 1986, then SeaWiFS aircraft simulator (SASII) instruments since 1997. Mapping is incomplete in tributaries (Kopp et al. 2002).

The Alliance for Chesapeake Bay Citizen’s Monitoring Program (ACBCMP) monitors water quality at sites along the York and James Rivers near COLO. Shoreline sites have been monitored weekly since 1985 for dissolved oxygen, pH, salinity, and turbidity, and limited nutrient data (e.g. nutrients, water clarity, total suspended solids, and chlorophyll) are occasionally collected (VA DEQ 2002).

The VA Chesapeake Bay Program conducts phytoplankton (for nuisance/harmful species) and benthic monitoring in the lower York and James Rivers, but not the small tidal creeks of COLO (Kopp et al. 2002). This monitoring has been on going since 1985.

#### *Other Monitoring Data Sources*

There is no NADP (National Atmospheric Deposition Program) site within COLO or in the immediate area. The closest NADP site is MD18 at ASIS or VA24 in Prince Edward County, VA. However, in 2002 the NPS-Air Quality Division recommended establishing a permanent air quality monitoring station, located and operated under EPA standards, within the park. Parameters that will be monitored include ozone, sulfur dioxide, PM-10, and meteorological data (wind speed and direction, dew point, relative humidity, precipitation, and solar radiation), additionally an automated camera visibility monitoring system is also proposed. The Yorktown Visitor Center was chosen for the construction of the monitoring station (Manter et al. 2002).

Landuse and land cover data are available from the NOAA Coastal Change Analysis Program, and national land cover data are available from the Multi-resolution Land Characteristics Consortium from 1991 and 1992 imagery. National Wetlands Inventory Data, based on aerial photographs taken between 1970 and 1990, are also available. A variety of GIS data are also available from the COLO GIS specialist.

Table 7-1. Water Quality Attainment Status for State Designated Uses [305(b) waters] and Impaired Waters [303(d) listed] for Colonial National Historical Park. Percentages indicate percent of water body (from 305(b) listing) that is impaired. Information is a summary from EPA Water Quality Inventory 305(b), EPA TMDL 303(d) Reports, and 2002 Virginia Department of Environmental Quality 305(b) and 303(d) Reports. If a 305(b) ID is not listed then the corresponding 305(b) report for that segment of the water body could not be found. None of these water bodies had TMDL's reported to EPA by Virginia. VDH: Virginia Department of Health. "na" indicates information could not be found.

Waterbody	Listing Cycle	305 b Assessment Unit ID	303(d) List ID	Integrated List Category	Water Quality Attainment Status for State Designated Uses & Impairment
Baptist Run	2000	VAT-G11R_BAP01A00	Not listed	2a	<b>Fully supports:</b> aquatic life, fish consumption, primary contact recreation. <b>Not assessed:</b> drinking water supply & shellfishing <b>Water Impairment:</b> not 303(d) listed <b>Source:</b> not 303(d) listed
Cheatham Pond	2000	VAT-F26L_06	Not listed	2a	<b>Fully supports:</b> aquatic life, fish consumption, & primary contact recreation. <b>Water Impairment:</b> not 303(d) listed <b>Source:</b> not 303(d) listed
College Creek	2000	VAT-G10E_CLG01A00	Not Listed	2a	<b>Fully supports:</b> aquatic life, fish consumption, & primary contact recreation. <b>Not Assessed:</b> shellfishing, & drinking water supply <b>Water Impairment:</b> not 303(d) listed <b>Source:</b> not 303(d) listed
Felgate's Creek	2000	VAT-F27E_FEL01A00	VAT-F26E_SF_A	5	<b>Fully supports:</b> aquatic life, fish consumption, & primary contact recreation. <b>Partially supports:</b> shellfishing (100%) <b>Not Assessed:</b> drinking water supply <b>Water Impairments:</b> pathogens, VDH shellfish restriction <b>Source:</b> non-point source

Waterbody	Listing Cycle	305 b Assessment Unit ID	303(d) List ID	Integrated List Category	Water Quality Attainment Status for State Designated Uses & Impairment
Indian Field Creek	2002	Not listed	VAT-F27E_IFC01A00	5	<i>Attainment status not found</i> <b>Water impairments:</b> VDH shellfish restriction <b>Source:</b> unknown
James River	1998	Not listed	VAT-G10E-04	5	<b>Partially supports:</b> aquatic life <b>Water Impairments:</b> nutrients <b>Source:</b> unknown
Jones Mill Pond	2000	VAT-F26L_05	Not Listed	2a	<b>Fully supports:</b> aquatic life, fish consumption, drinking water, & primary contact recreation. <b>Water Impairment:</b> not 303(d) listed <b>Source:</b> not 303(d) listed
King Creek (estuary)	1998	VAT-F27E_KNG01A00	VAT-F27E_SF_B VAT-F27E_SF_C	5	<b>Fully supports:</b> fish consumption <b>Partially supports:</b> aquatic life support (100%), shellfishing (100%), & primary contact recreation (100%) <b>Not assessed:</b> drinking water supply <b>Water Impairments:</b> organic enrichment/low dissolved oxygen, pathogens, VDH shellfish restriction <b>Source:</b> natural sources, non-point sources
King Creek (at Colonial Parkway Crossing, river mile 3.96 to 4.96)	1998	Not listed	VAT-F27E_A VAT-F27E_07 (segment ID)	na	<b>Partially supports:</b> aquatic life support, & primary contact recreation <b>Water Impairments:</b> fecal coliform, dissolved oxygen <b>Source:</b> Natural conditions & unknown
King Creek (river mile mouth to 0.68 miles)	1998	Not listed	VAT-F27E-08 (segment ID)	na	<b>Partially supports:</b> fish consumption <b>Water Impairments:</b> fish tissue PCBs <b>Source:</b> unknown, may be related to sediment PCBs in Queen Creek sediments

Waterbody	Listing Cycle	305 b Assessment Unit ID	303(d) List ID	Integrated List Category	Water Quality Attainment Status for State Designated Uses & Impairment
Mill Creek <i>Segment begins at the end of tidal influence and extends to the confluence with the James River</i>	2000	VAT-G10E_MIC01A00	VAT-G10E-03 (segment ID)	5	<b>Fully supports:</b> aquatic life support, fish consumption <b>Partially supports:</b> primary contact recreation (100%) <b>Not assessed:</b> drinking water supply & shellfishing <b>Water Impairment:</b> Fecal coliform <b>Source:</b> unknown
Powhatan Creek <i>Segment extends from estuarine transition to confluence with Long Hill Swamp</i>	2000	VAT-G10R_POW01A00	VAT-G10R-02	5	<b>Fully supports:</b> fish consumption, & primary contact recreation <b>Partially supports:</b> aquatic life support <b>Not assessed:</b> drinking water supply & shellfishing <b>Water Impairment:</b> General standard (benthic) <b>Source:</b> unknown
Powhatan Creek <i>Rt 31 bridge to confluence with Sandy Bay</i>	2000	VAT-G10E_POW01A00	VAT-G10E-02 VAT-G10E-01	5	<b>Fully supports:</b> aquatic life support & fish consumption <b>Partially supports:</b> primary contact recreation (100%) <b>Not assessed:</b> drinking water supply & shellfishing <b>Water Impairments:</b> fecal coliform, pathogens <b>Source:</b> unknown
Queen's Creek <i>(headwaters of creek to confluence with York River)</i>	1998, 2000	VAT-F26E_QEN01A00	VAT-F26E VAT-F26E_QEN01A00 (Segment ID) VAT-F26E-11 (Segment ID)	5	<b>Fully supports:</b> fish consumption <b>Partially supports:</b> Aquatic life support (100%) & shellfishing (100%), primary contact recreation <b>Not assessed:</b> drinking water supply <b>Water Impairments:</b> organic enrichment/low dissolved oxygen, fecal coliform, pathogens, sediment PCBs, VDH shellfish restriction <b>Source:</b> unknown & natural sources

Waterbody	Listing Cycle	305 b Assessment Unit ID	303(d) List ID	Integrated List Category	Water Quality Attainment Status for State Designated Uses & Impairment
Queen's Creek (at confluence with York River)	2000	VAT-F26E_QEN01B00	VAT-F26E_SF_H	na	<b>Fully supports:</b> fish consumption <b>Partially supports:</b> shellfishing (100%) <b>Threatened:</b> aquatic life support <b>Not supporting:</b> primary contact recreation (100%) <b>Not assessed:</b> drinking water supply <b>Water Impairments:</b> PCB's, sedimentation/siltation, & pathogens, VDH shellfish restriction <b>Source:</b> unknown, natural sources, & non-point source
Roosevelt Pond	2000	VAT-F27L_05	Not listed	2a	<b>Fully supports:</b> aquatic life, fish consumption, & primary contact recreation. <b>Water Impairment:</b> not 303(d) listed <b>Source:</b> not 303(d) listed
York River	2000	VAT-F27E_YRK01A00	VAT-F27E_03 VAT-F26E_01	5	<b>Fully supports:</b> fish consumption, shellfishing, & primary contact recreation. <b>Partially supports:</b> aquatic life support (100%) <b>Not assessed:</b> Drinking water supply <b>Water impairments:</b> organic enrichment/low dissolved oxygen, nutrients <b>Source:</b> natural & unknown sources
York River	2002	This reach not listed	VAT-F27E_18	5	<b>Not supporting:</b> aquatic life support <b>Water impairments:</b> General standard (benthic) <b>Source:</b> unknown

Website addresses:

EPA Water Quality Inventory 305(b) website: <http://www.epa.gov/waters/305b/index.html>

EPA TMDL 303(d) Reports: <http://www.epa.gov/waters/tmdl/index.html>

Virginia Department of Environmental Quality 2002 303(d) Report: <http://www.deq.state.va.us/water/303d.html>

Table 7-2. Vegetation classifications, total hectares, and percent of total area for COLO. Areas calculated from COLO GIS coverages (based on 1989 aeriels).

Classification	Total Hectares	Percent of Total Area
Water		
Creek	59.4	1.7%
Pond	42.3	1.2%
River	9.4	0.3%
Swamp	4.7	0.1%
Other	15.1	0.4%
Vegetation		
Bare Ground	4.7	0.1%
Brush	14.1	0.4%
Field	392.3	11.3%
Forest	2035.5	58.7%
Lawn	23.6	0.7%
Forested Wetlands	252.1	7.3%
Tidal Wetlands	615.7	17.6%

Table 7-3. Area (ha) and percent of wetland areas adjacent to 303(d) listed waterbodies. Areas calculated from GIS coverages (based on 1989 aeriels). VHD: Virginia Department of Health

303(d) Waterbody	Impairment	Forested Wetlands	Tidal Wetlands	Total Wetlands
Felgate's Creek	Pathogens, VDH shellfish restriction	0	0	0
Indian Field Creek	VDH shellfish restriction	0	0.2 (<0.1%)	0.2
James River	nutrients	5.4 (0.6%)	315.7 (36.4%)	321.1
King Creek	organic enrichment, low dissolved oxygen, pathogens, VDH shellfish restriction, fecal coliform, fish tissue PCBs	0.4 (<0.1%)	24.7 (2.8%)	25.1
Mill Creek	Fecal coliform	0	0.7 (0.1%)	0.7
Powhatan Creek	general benthic standard, fecal coliform, pathogens	<0.1 (<0.1%)	34.9 (4.0%)	34.9
Queen Creek	organic enrichment, low dissolved oxygen, pathogens, VDH shellfish restriction, fecal coliform, sedimentation & siltation, sediment PCBs	2.1 (0.2%)	3.3 (0.4%)	5.4
York River	general benthic standard, organic enrichment, low dissolved oxygen, nutrients	0.3 (<0.1%)	7.4 (0.9%)	7.7
Other wetlands	Not 303(d) listed	243.8 (28.1%)	228.9 (26.4%)	472.7

Table 7-4. Summary of long-term wetland and water quality monitoring programs within COLO. ACBCMP: Alliance for Chesapeake Bay Citizen's Monitoring Program CBNERR: Chesapeake Bay National Estuarine Research Reserve; VACBP: VA Chesapeake Bay Program

Monitoring Program	Time period	Agency	Data available
Biotic (Lower York and James Rivers)	1985 to present	VACBP	Phytoplankton (nuisance/harmful species) and benthic monitoring
Water Quality (York River)	1997 to present	CBNERR	Chlorophyll- <i>a</i> , Secchi depth, diffuse attenuation coefficient of PAR, ammonium, nitrate, nitrite, and phosphate
Water Quality (York and James Rivers)	1985 to present	ACBCMP	Dissolved oxygen, pH, salinity, and turbidity, and limited nutrient data are occasionally collected.

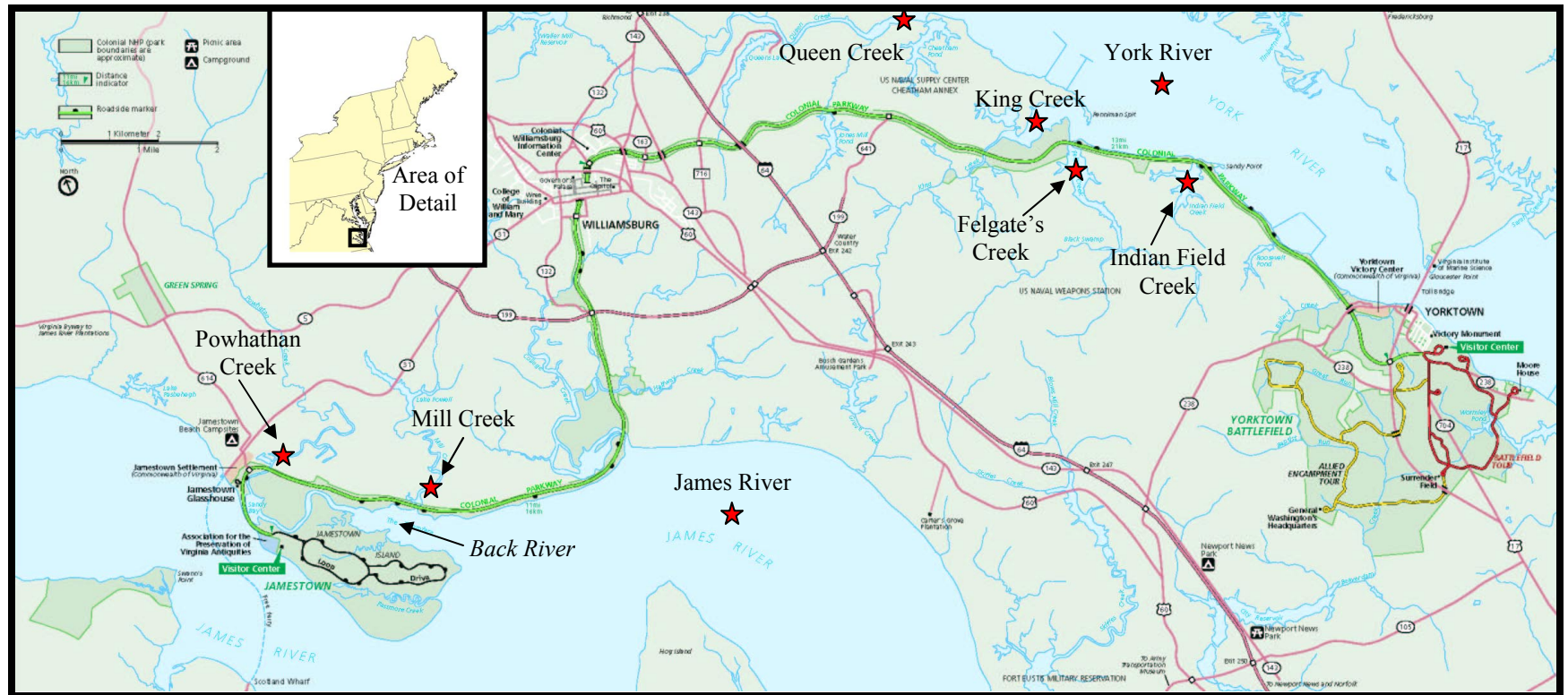
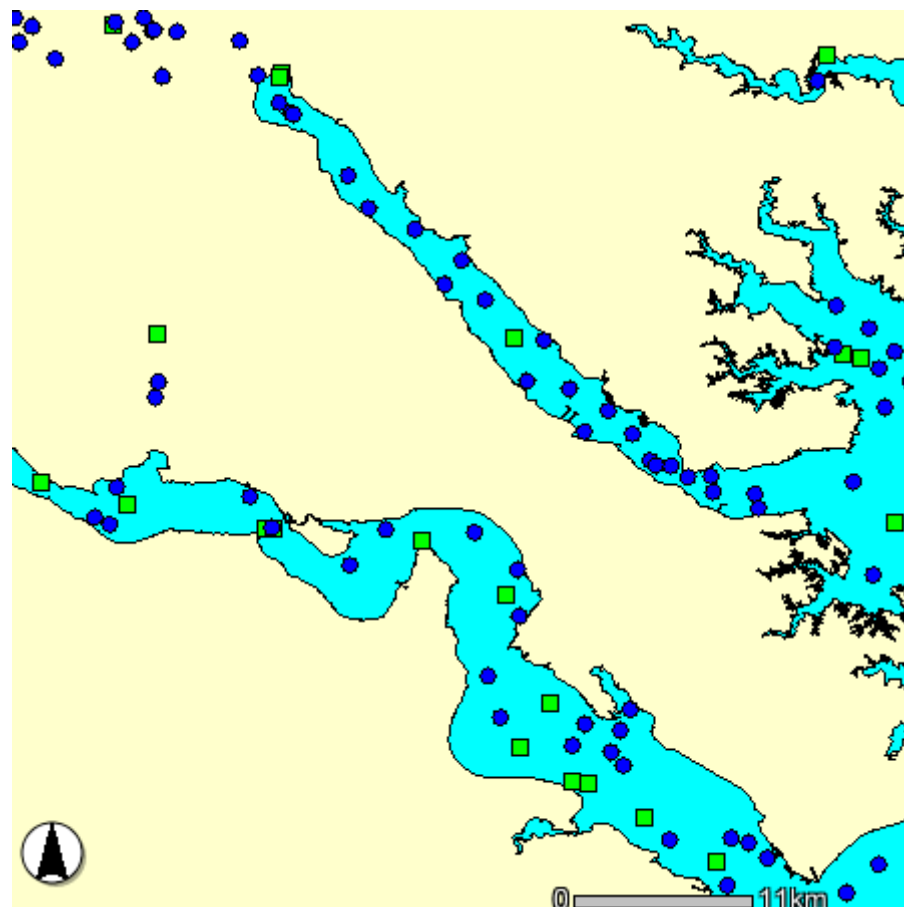


Figure 7-1. Map of Colonial National Historic Park and surrounding waters. Shaded areas indicate Park lands. Stars indicate 303(d) listed waters.



- Sampling Stations:
- Virginian Province (1990 to 1993)
  - Mid Atlantic Integrated Assessment (1997 & 1998)

Figure 7-2. Map of sampling stations (and sampling years) for the Environmental Monitoring and Assessment Program (EMAP) near COLO. Station data depicted above were produced by the U.S. Environmental Protection Agency through its EMAP Program, <http://www.epa.gov/emap>.

## **Chapter 8 - Fire Island National Seashore**

### Water Quality

Fire Island National Seashore (FIIS) encompasses 7,900 ha of land on the south shore of Long Island, New York (Fig. 8-1). FIIS was established to preserve the unspoiled and undeveloped beaches, dunes and other natural features of Fire Island, and includes 42 km of a dynamic barrier island with high dunes and centuries-old maritime forests. Wetlands of FIIS include extensive salt marshes on the back side of the barrier island bordering Great South Bay and Moriches Bay

In 1993, the New York State Legislature passed the South Shore Estuary Reserve Act which created the South Shore Estuary Reserve (SSER date unknown). The reserve extends from the western most portion of Hempstead Bay to the eastern most portion of Shinnecock Bay, thus encompassing the estuarine waters of FIIS (SSER date unknown). Although not within the National Estuary Program, the organization and resource-management strategies of the SSER are consistent with those of the National Estuary Program (Kopp et al. 2002). Enacting legislation did not explicitly allow for the participation of the National Park Service and FIIS has not been represented as a council member of the SSER (Kopp et al. 2002; SSER date unknown). In October of 2002, the Nature Conservancy acquired 4,650 ha, donated by Blue Points Oyster Company, along the bottom of Great South Bay adjacent to FIIS. This acquisition is part of a much larger project that involves protecting and restoring integrity of the entire 190 km coastal system of Long Island's South Shore (The Nature Conservancy 2004).

A summary of 305(b) and 303(d) water quality information for FIIS is presented in Table 8-1. Information is a summary from EPA Water Quality Inventory 305(b), EPA TMDL 303(d) Reports, 2000 New York State Water Quality 305(b) Report, and the New York 2002 303(d) List (NY-DEC 2000). All coastal Bays adjacent to FIIS (Great South Bay, Moriches Bay, and South Oyster Bay) are impaired by pathogens from urban and storm runoff, but agriculture runoff is also a source. The pathogens primarily impact the designated use of shellfishing in all Bays adjacent to FIIS. The Forge River, which is adjacent to the William Floyd Estate, is also impaired by pathogens from urban, storm, and agriculture runoff, and shellfishing is impacted.

### Outstanding Resource Waters

Information on Outstanding Resource Waters could not be found for the state of New York.

### Wetland Area

Twenty-five percent (630 ha) of FIIS lands are wetlands (Table 8-2). There are approximately 49 ha of forested wetland and 581 ha of non-forested wetlands within the Park. Since the impaired waterbodies within FIIS consist of the coastal embayments between the mainland and the barrier island (Fig. 8-1), the wetlands that are most likely

impaired are salt marshes (low and high salt marsh vegetation classifications). Potentially 426 ha (68% of the total wetland area of FIIS) of salt marshes may be influenced by pathogens in the adjacent coastal waters (Table 8-3).

### Wetland and Water Quality Issues

#### *All Habitats and Waters*

FIIS is located 88 km from downtown Manhattan, New York, and lies within the midst of the highly urbanized and suburbanized northeast coastal zone. As such land use outside of the park is the primary influence on waters within the boundaries of FIIS. The watershed surrounding Great South Bay can be described as “developing”, in contrast to the watersheds of the more western Bays (i.e. Hempstead and Oyster Bay), and as a result non-point source pollution (nutrients, sediment, and coliform bacteria) from stormwater runoff are primary impacts to the Bay. Vessel waste discharge and waterfowl also contribute to the bacterial load. Elevated levels of coliform bacteria are responsible for the periodic closures of shellfishing grounds and bathing beaches of Great South Bay (SSER date unknown). The watershed of the eastern Bays (Moriches Bay and Shinnecock Bay) are developed to a lesser extent than those surrounding Great South Bay, however elevated levels of fecal coliform bacteria from stormwater runoff are still present, and are responsible for the closure of shellfish beds. Sediment, nutrients, waterfowl waste, and fertilizers and pesticides (from agriculture) also impact the eastern bays’ water quality (SSER date unknown). Brown tides are considered a dominant perennial problem in Great South Bay (Kopp et al. 2002). As a component of its comprehensive management plan, the SSER will be developing a coordinated ecosystem monitoring strategy (SSER date unknown).

### Monitoring Programs (Table 8-4)

#### *Estuarine and Marine*

The Office of Ecology of the Suffolk County Government routinely monitors water quality of marine surface waters throughout the county. Starting in 1977 data has been collected at 42 stations throughout the estuary, biweekly from May to September and monthly during the rest of the year. Monitoring variables include: temperature, salinity, dissolved oxygen, Secchi depth, a full suite of organic and inorganic nitrogen and phosphorus nutrients plus inorganic silica, chlorophyll-*a*, *Aureococcus* abundance, and bacteriological monitoring. Twenty stations of this program fall within, or in close proximity to FIIS (Suffolk County Government website; Kopp et al. 2002). To the west of FIIS, the town of Hempstead conducts monthly monitoring within East Bay and West Bay at 30 stations. Monitoring variables include Secchi depth, temperature, salinity, dissolved inorganic nitrogen and phosphorus, particulate inorganic matter, chlorophyll-*a*, dissolved oxygen, biochemical oxygen demand, and bacteriological monitoring (Kopp et al. 2002).

*Pfiesteria* monitoring by the New York Department of Environmental Conservation (NY-

DEC), Suffolk County, and the town of Hempstead. Monitoring was initiated in 1999 at 27 stations in Suffolk County and Hempstead. Monitoring parameters include: temperature, salinity, nutrients, total suspended solids, and chlorophyll-*a*. Sampling occurs 1 to 3 times starting in July (Kopp et al. 2002).

FIIS was selected as one of the Northeast Coastal and Barrier Network Units to implement long-term monitoring protocols for salt marsh vegetation and estuarine nekton (Roman et al. 2001; Raposa & Roman 2001) developed at Cape Cod National Seashore for the Long-Term Monitoring Program. In the summer of 2003, vegetation and nekton were sampled at two marshes (Hospital Point and Watch Hill) (James-Pirri, University of Rhode Island, unpublished data). These data will serve as baseline data and it is hoped that these sites will be sampled long-term.

SETs (sediment elevation tables) were installed at 3 marshes within FIIS in 2002 (Watch Hill, Hospital Point, and Great Gun Meadows). SETs are initially monitored by the USGS with the NPS responsible for long-term monitoring (C. Roman, National Park Service, personal communication).

In April 2004, the high resolution QuickBird-2 satellite took photographs of submerged aquatic vegetation (SAV) and terrestrial land cover of Fire Island. These photos will be used to map SAV and to facilitate dynamic monitoring of terrestrial vegetation (Laboratory for Terrestrial Remote Sensing website; M. Traber, University of Rhode Island, personal communication). The New York State Department of Environmental Conservation (NY-DEC) also conducts aerial photographic surveys for wetland delineation every five years (Kopp et al. 2002).

The National Park Service Water Resource Division and Servicewide Inventory and Monitoring Program is currently conducting a baseline water quality data inventory and analysis of all surface waters (fresh, estuarine, and marine) for FIIS (NPS-WRD website).

The EPA's National Coastal Assessment, also known as Coastal 2000, the Regional Environmental Monitoring and Assessment Program (REMAP), and Environmental Monitoring and Assessment Program (EMAP) monitor a variety of parameters within North Shore Bays and Long Island Sound in the 1990's and more recently in 2000. In 2000, one station was located within Great South Bay and one station in Moriches Bay (Fig. 8-2). Specific parameters that are monitored include (Coastal 2000; EPA EMAP website):

- Water quality: dissolved oxygen, salinity, temperature, depth, pH, nutrients, chlorophyll
- Sediment quality: grain size, total organic carbon, sediment chemistry, benthic community structure, sediment toxicity
- Biota: benthic community structure, fish community structure, fish external pathology, fish tissue analyses

The USGS maintains a National Water Information System (NWIS) water quality website, NWISweb Data for the Nation, where realtime data and archived data on surface

water flow and levels in streams, lakes, springs, groundwater well levels, and water quality data from approximately 1.5 million stations nationwide can be queried (USGS 2004). A USGS water quality station was in operation from 1969 to 1974 on Great South Bay at Fire Island (USGS 403834073155900).

#### *Other Monitoring Data Sources*

There is no NADP (National Atmospheric Deposition Program) station located within FIIS. The closest NADP site (NY96) is at Southold, NY (Suffolk County) on the tip of Long Island. However, NY-DEC maintains an atmospheric deposition monitoring site at Hempstead (Nassau County) since 1987 (Eisenhower Park station #2950-10) and at the New York Botanical Gardens in the Bronx since 2000 (Botanical Gardens station #7094-06) (NY-DEC website).

Landuse and land cover data are available from the NOAA Coastal Change Analysis Program, and national land cover data are available from the Multi-resolution Land Characteristics Consortium from 1991 and 1992 imagery. National Wetlands Inventory Data, based on aerial photographs taken between 1970 and 1990, are also available. Suffolk and Nassau County planning agencies track landuse, and the proportion of counties covered by impervious surfaces (Kopp et al. 2002). Detailed vegetation maps based on aerial imagery from 1997 (Klopfer et al. 2002) are also available from FIIS GIS specialist

Table 8-1. Water Quality Attainment Status for State Designated Uses [305(b) waters] and Impaired Waters [303(d) listed] for Fire Island National Seashore. Percentages indicate percent of water body (from 305(b) listing) that is impaired. Information is a summary from EPA Water Quality Inventory 305(b), EPA TMDL 303(d) Reports, 2000 New York State Water Quality 305(b) Report (which also lists the 1998 303(d) list), and the New York 2002 303(d) List. New York has not yet submitted detailed electronic water quality assessment data in standard format to EPA and therefore 305(b) Assessment Unit IDs are not available. In 2002, New York State subdivided larger bodies of water into smaller areas (e.g. Great South Bay was subdivided into individual bays such as Narrow Bay, Bellport Bay, Patchogue Bay, *etc.*). “na” indicates information could not be found.

Waterbody	Listing Cycle	305 b Assessment Unit ID	303(d) List ID	Integrated List Category or Class	Water Quality Attainment Status for State Designated Uses & Impairment
Bellport Bay (Eastern Great South Bay)	2002	Not listed	NY-1701-0320	na, SA	<b>Impaired:</b> Shellfishing <b>Water Impairment:</b> Pathogens <b>Source:</b> urban/storm runoff
Forge River	2002	Not listed	NY-1701-0316	na, SA	<b>Impaired:</b> Shellfishing <b>Water Impairment:</b> Pathogens <b>Source:</b> urban/storm runoff, agriculture
Great South Bay (West)	2000	Not listed	NY-170--0173	na, SA	<b>Precluded:</b> Shellfishing <b>Water Impairment:</b> Pathogens <b>Source:</b> urban runoff
Great South Bay (Central)	2000	Not listed	NY-1701--0040	na, SA	<b>Precluded:</b> Shellfishing <b>Water Impairment:</b> Pathogens <b>Source:</b> urban runoff
Great South Bay (East)	2000	Not listed	NY-1701--0039	na, SA	<b>Precluded:</b> Shellfishing <b>Water Impairment:</b> Pathogens <b>Source:</b> urban runoff

Waterbody	Listing Cycle	305 b Assessment Unit ID	303(d) List ID	Integrated List Category or Class	Water Quality Attainment Status for State Designated Uses & Impairment
Narrow Bay (Eastern Great South Bay)	2002	Not listed	NY-1701-0318	na, SA	<b>Impaired:</b> Shellfishing <b>Water Impairment:</b> Pathogens <b>Source:</b> urban/storm runoff, agriculture
Nicoll Bay (Central Great South Bay)	2002	Not listed	NY-1701-0375	na, SA	<b>Impaired:</b> Shellfishing <b>Water Impairment:</b> Pathogens <b>Source:</b> urban/storm runoff
Moriches Bay	2000	Not listed	NY-1701--0038	na, SA	<b>Precluded:</b> Shellfishing <b>Water Impairment:</b> Pathogens <b>Source:</b> storm sewers
Patchogue Bay (Eastern Great South Bay)	2002	Not listed	NY-1701-0326	na, SA	<b>Impaired:</b> Shellfishing <b>Water Impairment:</b> Pathogens <b>Source:</b> urban/storm runoff
South Oyster Bay	2002	Not listed	NY-1701--0041	na, SA	<b>Precluded:</b> Shellfishing <b>Water Impairment:</b> Pathogens <b>Source:</b> urban & storm runoff

Website addresses:

EPA Water Quality Inventory 305(b) website: <http://www.epa.gov/waters/305b/index.html>

EPA TMDL 303(d) Reports: <http://www.epa.gov/waters/tmdl/index.html>

2000 New York State Water Quality Report (which also lists the 1998 303(d) list: <http://www.dec.state.ny.us/website/dow/305b00.pdf>

New York 2002 303(d) List: <http://www.dec.state.ny.us/website/dow/303dlist.pdf>

Table 8-2. Vegetation classifications, total hectares, and percent of total area for FIIS. Areas calculated from FIIS GIS coverages (aerial imagery from 1997).

<b>Classification</b>	<b>hectares</b>	<b>Percent of Total Area</b>
Water		
Inland water	7.0	0.3%
Mosquito Ditch	17.2	0.7%
Upland Vegetation		
Autumn Olive	6.1	0.2%
Beach Heather Dune	75.2	3.0%
Boardwalk/Dock	6.5	0.3%
Coastal Oak-Heath Forest	97.1	3.8%
Commercial Property	1.6	<0.1%
Cultivated Pasture	19.0	0.7%
Interdune Beachgrass-Beach Heather Mosaic	38.7	1.5%
Japanese Black Pine Forest	79.6	3.1%
Lawn/Cut Grass	49.3	1.9%
Maritime Deciduous Scrub Forest	262.7	10.2%
Maritime Holly Forest	26.3	1.0%
Maritime Post Oak Forest	0.3	<0.1%
Maritime Vine Dune	3.5	0.1%
Northern Beach Grass Dune	249.6	9.7%
Northern Dune Shrubland	186.5	7.3%
Northern Salt Shrub	76.3	3.0%
Northern Sandplain Grassland	1.6	<0.1%
Open Beach	320.5	12.5%
Overwash Dune Grassland	3.9	0.2%
Paved Road	53.3	2.1%
Pavement/Parking Area	19.0	0.7%
Pitch Pine Dune Woodland	15.4	0.6%
Pitch Pine-Oak Forest	18.4	0.7%
Residence/Building	83.0	3.2%
Rock Piles or Jetties	0.8	<0.1%
Sand Road/Path	42.8	1.7%
Sparsely Vegetated Sand	179.7	7.0%
Forested Wetland		
Acidic Red Maple Basin Swamp	5.9	0.2%
Highbush Blueberry Shrub Swamp	43.0	1.7%
Non-forested Wetland		
Brackish Interdunal Swale	4.1	0.2%
Brackish Meadow	5.8	0.2%
High Salt Marsh	199.6	7.8%
Low Salt Marsh	226.3	8.8%
Northern Interdunal Cranberry Swale	3.3	0.1%
Reedgrass Marsh	142.0	5.5%

Table 8-3. Area (ha) and percent of wetland areas (low and high salt marsh only) adjacent to 303(d) listed waterbodies. Areas calculated from FIIS GIS coverages (aerial imagery from 1997).

<b>Waterbody</b>	<b>Impairment</b>	<b>Forested wetlands</b>	<b>Non-forested wetlands</b>	<b>Total Wetlands</b>
Great South Bay – East (contains Bellport and Patchogue Bays)	Pathogens	0	169.1 (26.8%)	169.1
Great South Bay - Central (Contains Nicoll Bay)	Pathogens	0	64.4 (10.2%)	64.4
Great South Bay - West	Pathogens	0	1.0 (0.2%)	1.0
Moriches Bay	Pathogens	0	137.0 (21.7%)	137.0
Narrow Bay	Pathogens	0	54.4 (8.6%)	54.4
Other Wetlands	Not 303(d) listed	48.9 (7.8%)	155.2 (24.6%)	204.1

Table 8-4. Summary of long-term wetland and water quality monitoring programs within FIIS. SCG: Suffolk County Government;

Monitoring Program	Time period	Agency	Data available
Water Quality (marine surface waters of Suffolk Cty)	1977 to present	SCG	Temperature, salinity, dissolved oxygen, Secchi depth, a full suite of organic and inorganic nitrogen and phosphorus nutrients plus inorganic silica, chlorophyll- <i>a</i> , <i>Aureococcus</i> abundance, and bacteriological monitoring

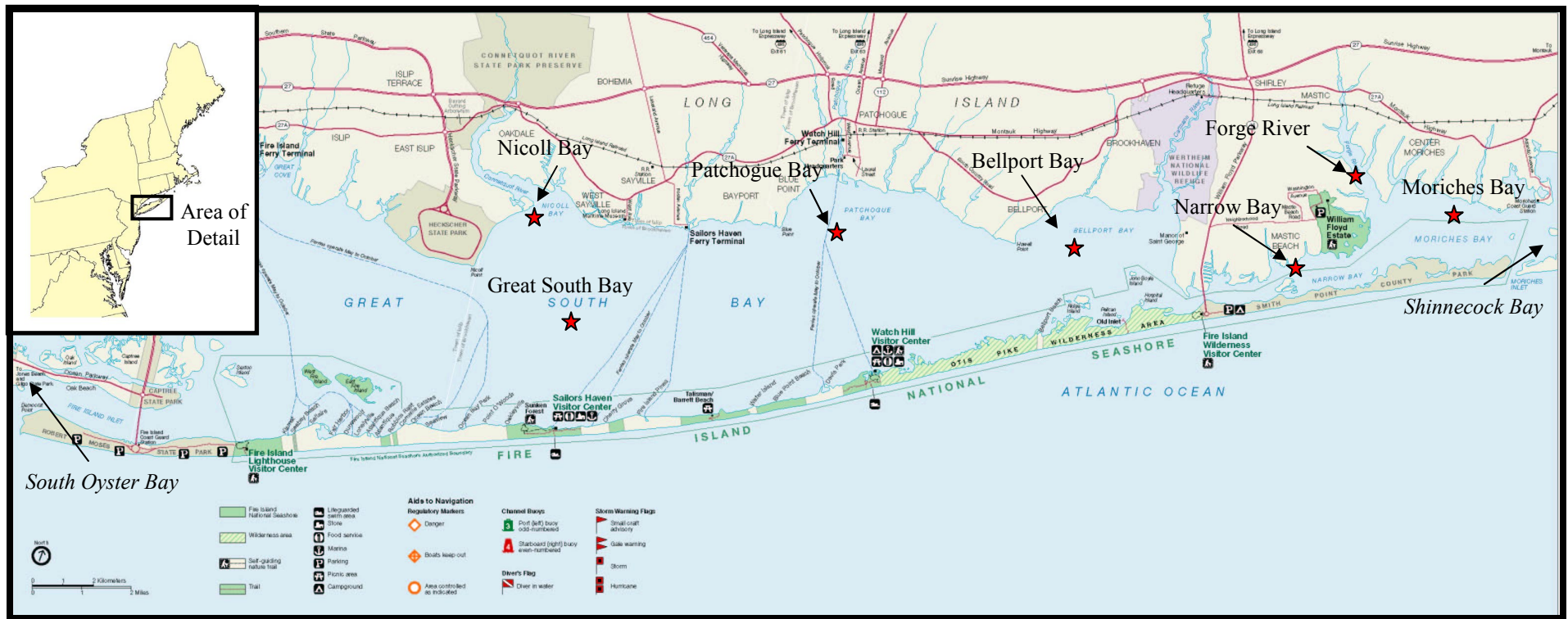


Figure 8-1. Map of Fire Island National Seashore and surrounding waters. Stars indicate 303(d) listed waters.

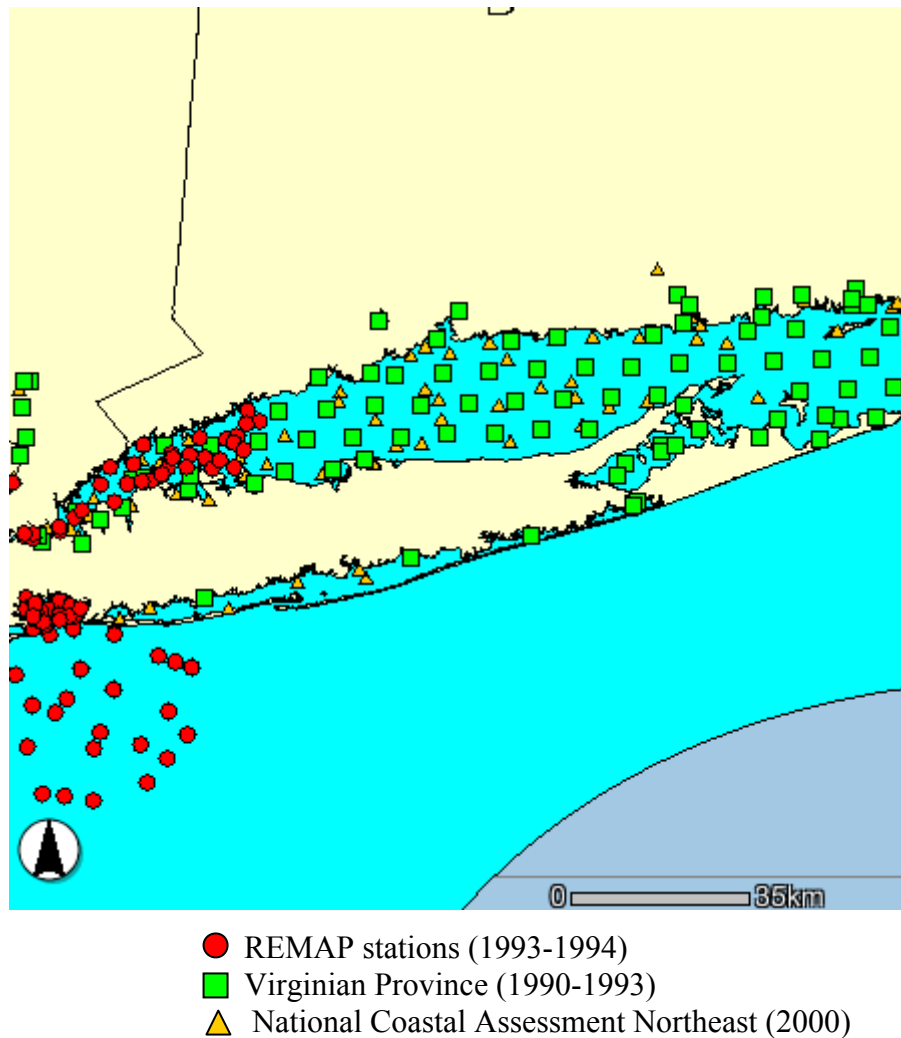


Figure 8-2. Map of sampling stations (and sampling years) for the Environmental Monitoring and Assessment Program (EMAP) surveys near FIIS. Station data depicted above were produced by the U.S. Environmental Protection Agency through its EMAP Program, <http://www.epa.gov/emap>.

## Chapter 9 - Gateway National Recreation Area

### Water Quality

Gateway National Recreation Area (GATE) is a 10,520 ha recreation area located in the heart of the New York metropolitan area. Approximately 6,880 ha of this area is surface water which is used recreationally by the public (Tanacredi et al. 2003). The park is composed of three separate units located in three boroughs of New York City and northern New Jersey. The Jamaica Bay Unit has several islands located within Jamaica Bay, a tidal estuary on the south part of Brooklyn and Queens, New York; the Staten Island Unit is located on the south shore of Staten Island within Lower New York Bay; and the Sandy Hook Unit is in northern New Jersey and encompasses Sandy Hook, a peninsula that extends into Raritan Bay (Fig. 9-1). Wetland resources within GATE include extensive salt marshes within Jamaica Bay, small disturbed marshes of the Staten Island Unit, and salt marshes and freshwater ponds of Sandy Hook. The Jamaica Bay Wildlife Refuge is one of the most important urban wildlife refuges in the United States. Encompassing 3,704 ha, it is comprised of diverse habitats, including salt marsh, upland field and woods, several fresh and brackish water ponds and an open expanse of bay and islands.

A summary of 305(b) and 303(d) water quality information are presented in Table 9-1. Information is a summary from EPA Water Quality Inventory 305(b), EPA TMDL 303(d) Reports, 2000 New York State Water Quality 305(b) Report, and the New York 2002 303(d) List (NJ- 2002a, 2002b; NY-DEC 2000). Jamaica Bay receives an average daily discharge of 320 million gallons of treated waste water from sewage treatment plants (Tanacredi et al. 2003). The waters of Jamaica Bay are impaired by pathogens, nitrogen, oxygen demand from combined sewer overflows (CSOs), urban runoff, and municipal waste water discharge. These impairments preclude the designated use of bathing in Jamaica Bay (Table 9-1). The basins connected to Jamaica Bay (Mill, Paerdegat, Shellbank, and Bergen) are impaired by organic enrichment, low dissolved oxygen, pathogens, and nitrogen caused by storm sewers, urban/storm runoff, CSOs, municipal waste water discharge, and private septic systems. In these basins fish propagation and bathing are either impaired or precluded (Table 9-1). Hendrix Creek, which also feeds into Jamaica Bay, is impaired by pathogens, oxygen demand, and nitrogen from CSOs and urban/storm runoff, which impairs fish propagation. Pesticides and chlordane contamination, from urban runoff and sediments, are a problem in Ridder's Pond, impairing fish consumption (Table 9-1). East Rockaway Inlet is impaired by pathogens from urban/storm runoff which impair shellfishing. Fish propagation is precluded in Coney Island Creek due to low dissolved oxygen, pathogens and organic enrichment from CSOs, urban runoff, and on site waste water treatment systems (Table 9-1). In Lower New York Bay, which borders the Staten Island Unit of GATE, consumption of migratory fish species is impaired due to PCB's and pathogens from combined sewer overflows. Shellfishing is partially supported in Sandy Hook Bay, the waterbody adjacent to the Sandy Hook Unit of GATE. Fecal coliform, low dissolved

oxygen, chromium, copper lead, and mercury from unknown sources are also contaminants in this waterbody. The waters of the Atlantic Ocean adjacent to the GATE (King's County) are impaired by pathogens, from CSOs, which impair shellfishing, resulting in the closure of Jamaica Bay for this activity (Table 9-1).

### Outstanding Resource Waters

Information on Outstanding Resource Waters could not be found for the state of New York (Jamaica Bay and Staten Island Units). New Jersey Classifies Outstanding Resource Waters as Class FW1 and PL. There are no Class FW1 or PL waters within the Sandy Hook Unit of GATE.

### Wetland Area

Twenty-seven percent (1424 ha) of lands within GATE are wetlands, all of which are non-forested wetlands (Table 9-2). Since the impaired waterbodies within GATE consist of the coastal embayments and estuaries (Fig. 9-1), the wetlands that are most likely impaired are salt marshes (low and high salt marsh), some disturbed and natural reed marsh classifications, and areas exposed to estuarine waters (attached algae, peat outcrops). Approximately 90% of the wetlands within GATE are impaired by the adjacent estuarine waters (Table 9-3).

### Wetland and Water Quality Issues

#### *Estuarine and Marine Waters*

The estuarine waters of GATE are most heavily impacted by stormwater drainage from roadway runoff, waste water treatment plants for sewage (treated and untreated), combined sewer outfalls (CSOs), industrial effluents, ocean dumping (prohibited as of September 1997), Pennsylvania and Fountain Avenue Landfills, JFK International Airport, other toxic waste leachates, and the urban and agricultural runoff from the Hudson, Hackensack, Passaic, and Raritan River watersheds that drain into the New York-New Jersey Harbor region (NYC-DEC 2002; NPS 2001; NPS 1999). Water quality is especially impacted after rainfall events due to stormwater discharges and CSOs (NPS 2001; NPS 1999). All the units within GATE fall within the boundaries of the New York-New Jersey Harbor Estuary Program of the National Estuary Program (NEP) (NEP website). Priority management issues identified by the NEP for this region include nutrients, toxics, conventional pollutants, pathogens, contaminated seafood, human population growth, habitat loss and alteration, species loss and decline, fisheries loss and decline, sedimentation, and floatable debris (NEP website). The New York-New Jersey Harbor Estuary Program identified seven elements that were the primary cause of ecosystem and human use impairments for the region in their Comprehensive Conservation and Management Plan (NY-NJ HEP 1995). Those factors were: habitat loss and degradation, toxic chemical contamination, contaminated dredged materials, pathogens, floatable debris, nutrients and organic enrichment, and rainfall-induced discharges (NY-NJ HEP 1995).

### Monitoring Programs (Table 9-4)

#### *All Habitats and Waters*

The National Park Service Water Resource Division and Servicewide Inventory and Monitoring Program conducted a baseline water quality data inventory and analysis of all surface waters (fresh, estuarine, and marine) for GATE (NPS-WRD 1997a). There were 382 stations within the study area that contained data, and 150 of these were located within the park's boundary (75 within Jamaica Bay and Breezy Point Units, 51 within the Sandy Hook Unit, and 24 within the Staten Island Unit). The technical report presents the results of surface-water-quality data retrievals for GATE from five of the US EPA's national databases:

- Storage and Retrieval (STORET) database management system: Water quality parameter data, locations of sampling stations, descriptive elements about stations and parameters
- River Reach File (RF3): 1:100,000 scale geographical representation of surface waters (rivers, lakes, etc) with a unique identifier assigned to each surface water segment and connectivity information useful for routing and navigation.
- Industrial Facilities Discharge (IFD): Locations of industrial and municipal point source discharge facilities.
- Drinking Water Supplies (DRINKS): Locations of intake pipes for drinking water supplies.
- Stream Gages (GAGES): Locations of USGS and other discharge gages.

Provided within the GATE technical reports are: 1. complete inventory of all retrieved water quality parameter data, water quality stations, and the entities responsible for data collection; 2. descriptive statistics and appropriate graphical plots of water quality data characterizing annual and seasonal central tendencies and trends; 3. a comparison of GATE's water quality data relevant to EPA and WRD water quality screening criteria; 4. an Inventory Data Evaluation and Analysis (IDEA) to determine what Servicewide Inventory and Monitoring Program Level I water quality parameters have been measured within the study area. Level I water quality parameters identified by the Servicewide Inventory and Monitoring program were: alkalinity, pH, conductivity, dissolved oxygen, and rapid bioassessment baseline for fish and macroinvertebrates. Optional case-by-case parameters included toxic elements, clarity/turbidity, nitrate/nitrogen, phosphate/phosphorus, chlorophyll, sulfates, and bacteria (NPS-WRD 1997a). The results of the GATE water quality criteria screen found 18 groups of parameters that exceeded screening criteria at least once within the study area. Dissolved oxygen, pH, cadmium, copper, lead, mercury, silver, and zinc exceeded their respective EPA criteria for the protection of freshwater aquatic life. Dissolved oxygen, pH, chlorine, cadmium, copper, lead, mercury, nickel, silver, and zinc exceeded their respective EPA criteria for the protection of marine aquatic life. Antimony, beryllium, cadmium, lead, mercury, nickel, bis(2-ethylhexyl) phthalate, and tetrachloroethylene exceeded their respective EPA drinking water criteria. Fecal-indicator bacteria concentrations (total coliform, fecal

coliform, and enterococci) and turbidity exceeded the WRD screening limits for freshwater and marine water bathing, and aquatic life, respectively (NPS-WRD 1997a).

The USGS maintains a National Water Information System (NWIS) water quality website, NWISweb Data for the Nation, where realtime data and archived data on surface water flow and levels in streams, lakes, springs, groundwater well levels, and water quality data from approximately 1.5 million stations nationwide can be queried (USGS 2004). A USGS continuous gaging station has been in operation since 2002 at Rockaway Inlet near Floyd Bennett Field, NY (USGS 01311875), and a water quality station was in operation from 2000 to 2002 on Spring Creek at Howard Beach, Jamaica Bay, NY (USGS 01311826).

### *Freshwater*

Water quality data has been recorded for the freshwater ponds within GATE, however further information is not available (M. Ringenary, NPS, personal communication).

### *Estuarine and Marine*

GATE's Water Quality Program started in 1976 and has consistently sampled the same locations since 1981, with additional sites added in 2000 to 2001 within Jamaica Bay to assist with potential restoration activities within the Bay (NPS 2001). GATE monitors parameters to gather information on the water quality of bathing beaches to support primary contact recreation (i.e. swimming). The purpose of the program was to form a database for management of park waters for public health and ecological quality. GATE monitors 30 stations through GATE for water quality. At Sandy Hook, total and fecal coliform as well as *Enterococcus* bacteria are monitored; at Jamaica Bay, total and fecal coliform, chlorophyll- *a*, conductivity, dissolved oxygen, water depths are monitored; while nitrates, pH, phosphates, salinity, turbidity, and temperature are monitored at all units (NPS 2001; NPS 1999). The waters of the Staten Island Unit have been tested for total and fecal coliform (since 1977), while other parameters such as pH, salinity, turbidity, conductivity, dissolved oxygen, water depths, and temperature have been collected consistently since 1997 but they have not been reported in a summarized report (M. Ringenary, NPS, personal communication).

Monitoring is conducted weekly from mid-May to September and approximately monthly thereafter at six stations in the Sandy Hook Unit, eight stations in the Staten Island Unit, and at 9-15 bay stations and 2 Atlantic beach stations in the Jamaica Bay/Breezy Point Unit (Kopp et al. 2002; NPS 2001; NPS 1999).

The New York State Department of Environmental Conservation (NYS-DEC) has conducted a tidal wetlands trends analysis (from historical maps) that has revealed significant losses of vegetated tidal wetlands, principally *Spartina alterniflora* intertidal marshes, on the marsh islands of Jamaica Bay (NYS-DEC website; Kracauer Hartig et al. 2002). From 1924 to 1974, 522 ha were lost due to dredging, filling and other causes. Since 1974 (when dredging and filling of wetlands was regulated), the rate of salt marsh

loss has been accelerating. Between 1974 and 1994, 212 ha of marsh were lost (an average of 10 ha per year), and between 1994 and 1999, 89 ha were lost (an average rate of 18 ha per year), with the vegetated intertidal marsh being converted to nonvegetated underwater lands (NYS-DEC website). Potential contributing factors to these wetland losses include sediment budget disruption, sea level rise, dredging, wave energy, erosion, inlet stabilization, mussel dams on marshes, and eutrophication (NYS-DEC website; Kracauer Hartig et al. 2002). The NYS-DEC is continuing their tidal wetlands trend analysis for the entire marine district, including western and eastern portions of Long Island Sound, South Oyster Bay, New York City, Westchester County. In the future they hope to secure funds to perform a wetlands trend analysis for the South Shore Estuary Reserve, north shore harbors of Long Island Sound, and Peconic Bay. NYS-DEC is committed long-term monitoring of habitat conditions and trends in these wetland areas (NYS-DEC website). In an effort to restore wetlands losses, the National Park Service is conducting a demonstration restoration project at the Big Egg marsh in Jamaica Bay. The project involves dredging the adjacent tidal creek and spraying a thin layer of sediment onto the marsh using a high-pressure apparatus, with the goal of stemming marsh loss by building up sediment on the existing marsh. The sprayed marsh and a reference control area are currently being monitored for salt marsh vegetation, nekton, and surface elevation changes (C. Roman, NPS, personal communication).

In 2003, the results of the Jamaica Bay Ecosystem Research and Restoration Team (JABERRT), a 12-month (2000 to 2001) biogeochemical assessment of 12 sites within and around the periphery of Jamaica Bay, were published in a 3-volume report (Tanacredi et al. 2003). In general, restoration objectives of JABERRT for the 12-sites focused on the creation and/or enhancement of regularly-flooded intertidal coastal estuarine wetlands, for use by resident and migratory species. Specific restoration activities may involve a recontouring of uplands to intertidal elevations, removal of alien invasive plant species and/or the increasing of tidal water exchange in areas of reduced hydrologic “flushing” resulting in stagnant waters due to bulkheading, filling and/or construction of roads, housing, etc., over previous years (Tanacredi et al. 2003). The 12 sites are: Dead Horse Bay North and South, Gerritsen Creek, Paerdegat Basin, Fresh Creek, Spring Creek North and South, Bergen/Hawtree Basin, DuBos Point, Brant Point, Broad Channel, JoCo Marsh, Bayswater, and Ruffle Bar. Data were collected on fisheries including invertebrate and shellfish (using trawls, seines, and gill nets), hydrodynamics, birds (migratory and neo-tropical), terrestrial vegetation, environmental contaminants, reptile, amphibians, mammals, and butterflies (Tanacredi et al. 2003). These JABERRT data will supplement concurrently collected data by contractors employed by NYS-DEC, NYC-DEP and the Army Corps of Engineers in the development of restoration plans for non-Federal (non-NPS) lands/waters of Jamaica Bay. The National Park Service will use all existing data sites to establish within NPS boundaries a long-term inventory monitoring network to assist in establishing those vital signs in determining the health of the natural resources of Jamaica Bay and will utilize JABERRT data as it’s baseline for appropriate EA’s (Environmental Assessments) for site specific projects subject to NPS regulation, guidelines and policy (Tanacredi et al. 2003).

GATE and the US Fish and Wildlife Service have conducted intermittent monitoring as part of the Jamaica Bay Fisheries Survey since 1985. This survey includes 15 otter trawl sites, nine gill net sites, and six beach seine sites. In 2000 to 2001, monitoring was conducted on a monthly basis as part of the JABERRT project (Tanacredi et al. 2003; NPS 1991b)

GATE was selected as one of the Northeast Coastal and Barrier Network Units to implement long-term monitoring protocols for salt marsh vegetation and estuarine nekton (Roman et al. 2001; Raposa & Roman 2001) developed at Cape Cod National Seashore for the Long-Term Monitoring Program. In the summer of 2003, nekton were sampled at Big Egg Treatment and Big Egg Control marshes in the Jamaica Bay Unit. Vegetation is currently being monitored by GATE staff at these locations. Permanent vegetation plots and nekton stations were sampled within Horseshoe Cove marsh at the Sandy Hook Unit (James-Pirri, University of Rhode Island, unpublished data). These data will serve as baseline data and it is hoped that the permanent stations will be sampled long-term.

The US EPA's National Coastal Assessment, also known as Coastal 2000, the Regional Environmental Monitoring and Assessment Program (REMAP), and the Environmental Monitoring and Assessment Program (EMAP) monitor a variety of parameters within New York/New Jersey Harbor region and Sandy Hook Bay in the 1990's and more recently in 2000 (Fig. 9-2). Specific parameters that are monitored include (Coastal 2000; EPA EMAP website):

- Water quality: dissolved oxygen, salinity, temperature, depth, pH, nutrients, chlorophyll
- Sediment quality: grain size, total organic carbon, sediment chemistry, benthic community structure, sediment toxicity
- Biota: benthic community structure, fish community structure, fish external pathology, fish tissue analyses

The Interstate Environmental Commission (IEC) (formerly the Interstate Sanitation Commission), a tri-state water and air pollution control agency for New York, New Jersey, and Connecticut also has monitoring stations within GATE (IEC 2003). They monitor 67 stations in New York/New Jersey Harbor and Long Island Sound biweekly during the summer and monthly during the rest of the year. There are four stations in the immediate area of Sandy Hook Bay, and two stations adjacent to the Staten Island Unit. Parameters measured include temperature, salinity, dissolved oxygen, chlorophyll-a, turbidity, organic carbon, and a suite of nitrogen and phosphorus nutrient analyses (IEC 2003).

The New York City Department of Environmental Protection (NYC-DEP) has been monitoring water quality within New Harbor and vicinity since 1909. In 2002, 53 stations were monitored throughout the Harbor, including Jamaica Bay and Lower New York Harbor (NYC-DEP 2002). Stations are sampled weekly from mid-May through September, and one or twice per month the rest of the year (Kopp et al. 2002). There are eight stations within Jamaica Bay and Rockaway Inlet, one station in the Inner Harbor

near the Staten Island Unit. Water quality parameters that are measured include dissolved oxygen, fecal coliform, chlorophyll-*a*, and Secchi depth.

New York-New Jersey Harbor Estuary Program (NY-NJ HEP) has developed a Comprehensive Conservation and Management Plan for the harbor that includes a monitoring program for the region (NY-NJ HEP 1995). A variety of research conducted within the New York-New Jersey Harbor Estuary region can be found at the NY-NJ HEP website: <http://www.harborestuary.org/regindex.htm>.

HydroQual, Inc. developed a Eutrophication Model for Jamaica Bay in order to characterize the nutrient status of the bay and to evaluate possible remediation strategies. A sampling program collected data on phytoplankton, macroalgae, salt marsh plant biomass, and nutrient content between July 1995 and July 1996; and benthic bivalve samples were collected from 91 intertidal and subtidal sites throughout the bay from November 1996 to January 1996 (Myers et al. 1999).

SETs (sediment elevation tables) are installed at Big Egg Marsh (Jamaica Bay) and Horseshoe Cove (Sandy Hook Unit). SETs are initially monitored by the USGS with the NPS responsible for long-term monitoring (C. Roman, National Park Service, personal communication).

#### *Other Monitoring Data Sources*

There is no NADP (National Atmospheric Deposition Program) station located near GATE. The closest NADP sites are at West Point, NY (NY99) and Southold NY (NY96). However, NY-DEC maintains an atmospheric deposition monitoring site at Hempstead (Nassau County) since 1987 (Eisenhower Park station #2950-10) and at the New York Botanical Gardens in the Bronx since 2000 (Botanical Gardens station #7094-06) (NY-DEC website).

Detailed vegetation maps, based on data from 1976, are also available from the GATE GIS specialist.

Table 9-1. Water Quality Attainment Status for State Designated Uses [305(b) waters] and Impaired Waters [303(d) listed] for Gateway National Recreation Area. Percentages indicate percent of water body (from 305(b) listing) that is impaired. Information is a summary from EPA Water Quality Inventory 305(b), EPA TMDL 303(d) Reports, 2002 New Jersey 305(b) and 303(d) Reports, 2000 New York State Water Quality 305(b) Report (which also lists the 1998 303(d) list), and the New York 2002 303(d) List. New York and New Jersey have not submitted detailed electronic water quality assessment data in standard format to EPA at this time therefore 305(b) Assessment Unit IDs are not available at this time. “na” indicates information could not be found.

Waterbody	Listing Cycle	305 b Assessment Unit ID	303(d) List ID	Integrated List Category or Class	Water Quality Attainment Status for State Designated Uses & Impairment
Atlantic Ocean (Kings Cty)	2000	Not listed	NY-1701-0014	na, SA	<b>Precluded:</b> Shellfishing <b>Water Impairment:</b> pathogens <b>Source:</b> combined sewer overflow
Atlantic Ocean (Sandy Hook Unit)	Not listed	Not listed	Not listed	na, SC	Not listed
Bergen Basin	2002	Not listed	NY-1701-0009	na, I	<b>Impaired:</b> fish propagation <b>Water Impairment:</b> Organic enrichment, low dissolved oxygen, pathogens, nitrogen <b>Source:</b> combined sewer overflow, urban runoff, & municipal waste water discharge
Coney Island Creek	2002	Not listed	NY-1701-0008	na, I	<b>Precluded:</b> fish propagation <b>Water Impairment:</b> low dissolved oxygen, pathogens, organic enrichment <b>Source:</b> combined sewer overflow, urban runoff, onsite waste water treatment system
East Rockway Inlet	2002	Not listed	NY-1701-0217	na	<b>Impaired:</b> Shellfishing <b>Water Impairment:</b> pathogens <b>Source:</b> urban/storm runoff

Waterbody	Listing Cycle	305 b Assessment Unit ID	303(d) List ID	Integrated List Category or Class	Water Quality Attainment Status for State Designated Uses & Impairment
Hendrix Creek	2002	Not listed	NY-1701-0006	Na, I	<b>Impaired:</b> fish propagation <b>Water Impairment:</b> pathogens, oxygen demand, nitrogen <b>Source:</b> combined sewer overflow, urban/storm runoff
Jamaica Bay	2002	Not listed	NY-1701-0005	na, SB	<b>Precluded:</b> bathing <b>Water Impairment:</b> pathogens, nitrogen, oxygen demand <b>Source:</b> combined sewer overflow, urban runoff, municipal waste water discharge
Lower New York Bay	2002	Not listed	NY-1701-0004	na, SB	<b>Impaired:</b> Fish consumption (migratory species) <b>Water Impairment:</b> pathogens, PCBs <b>Source:</b> combined sewer overflow
Mill Basin	2002	Not listed	NY-1701-0178	na, SB	<b>Impaired:</b> bathing <b>Water Impairment:</b> Organic enrichment, low dissolved oxygen, pathogens, nitrogen <b>Source:</b> storm sewers, urban/storm runoff, combined sewer overflow, private systems
Paerdegat Basin	2002	Not listed	NY-1701-0003	na, I	<b>Precluded:</b> fish propagation <b>Water Impairment:</b> low dissolved oxygen, organic enrichment <b>Source:</b> combined sewer overflow, urban/storm runoff
Ridders Pond	2002	Not listed	NY-1701-0176	na, C	<b>Impaired:</b> fish consumption <b>Water Impairment:</b> pesticides, chlordane <b>Source:</b> urban runoff, contaminated sediment
Sandy Hook Bay	1998	Not listed	NJ-12CA-Sandy_Hook_Bay	na, SE1	<b>Impaired:</b> Shellfish consumption <b>Water Impairment:</b> fecal coliform <b>Source:</b> none listed

Waterbody	Listing Cycle	305 b Assessment Unit ID	303(d) List ID	Integrated List Category or Class	Water Quality Attainment Status for State Designated Uses & Impairment
Sandy Hook Bay Reach	2002	Not listed	NJ-02030104-006	5, SE1	<b>Impaired:</b> Aquatic life support <b>Water Impairment:</b> arsenic, copper, mercury, silver, & zinc (Lead & nickel removed from 2002 list due to new assessment method). <b>Source:</b> none listed
Sandy Hook Bay	2002	Not listed	914, 918, 908, 906A (NJ Site ID)	1&2, SE1	<b>Water Impairment:</b> fecal coliform, dissolved oxygen, chromium, copper, lead, mercury <b>Source:</b> none listed
Shellbank Basin	2002	Not listed	NY-1701-0001	na, I	<b>Precluded:</b> fish propagation <b>Water Impairment:</b> Organic enrichment/ low dissolved oxygen, Nitrogen <b>Source:</b> combined sewer overflow & urban/storm runoff

Website addresses:

EPA Water Quality Inventory 305(b) website: <http://www.epa.gov/waters/305b/index.html>

EPA TMDL 303(d) Reports: <http://www.epa.gov/waters/tmdl/index.html>

2000 New York State Water Quality Report, which also lists the 1998 303(d) list: <http://www.dec.state.ny.us/website/dow/305b00.pdf>

New York 2002 303(d) List: <http://www.dec.state.ny.us/website/dow/303dlist.pdf>

New Jersey 1998 303(d) List: <http://www.state.nj.us/dep/dsr/watershed/integratedlist/integratedlist.pdf>

Table 9-2. Vegetation classifications, total hectares, and percent of total area for GATE. Areas calculated from GATE GIS coverages (land cover data from 1976).

<b>Classification</b>	<b>hectares</b>	<b>Percent of total</b>
Water	96.2	1.8%
Tidal Pool (panne)	16.2	0.3%
<b>Uplands</b>		
Bare Sand	12.5	0.2%
Beach	347.2	6.5%
Beachgrass Dune	149.0	2.8%
Conifer Forest	2.3	<0.1%
Cultivated Plantings	31.4	0.6%
Deciduous Forest	149.2	2.8%
Deciduous Forest (transit	0.6	0.0%
Disturbed	190.7	3.6%
Heathland	21.0	0.4%
High Thicket	79.2	1.5%
Holly Forest	17.9	0.3%
Lawn	222.0	4.2%
Low Thicket	109.8	2.1%
Mixed Forest	12.1	0.2%
Mixed Grassland	488.7	9.1%
Open Shrubland	183.2	3.4%
Pavement	345.8	6.5%
Sand Flat	179.0	3.3%
Trails and Paths	7.7	0.1%
Urban - Buildings	1262.6	23.6%
<b>Non-forested Wetlands</b>		
Attached Algae	6.4	0.1%
Cattail Marsh	0.1	<0.1%
Disturbed Reed Marsh	518.9	9.7%
High Salt Marsh	301.5	5.6%
Low Salt Marsh	418.3	7.8%
Marsh Fern Marsh	0.4	<0.1%
Natural Reed Marsh	169.9	3.2%
Peat Outcrop	8.6	0.2%

Table 9-3. Area (ha) and percent of wetland areas adjacent to 303(d) listed waterbodies within GATE. Areas calculated from GATE GIS coverages (land cover data from 1976).

<b>Waterbody</b>	<b>Impairment</b>	<b>Forested wetlands</b>	<b>Non-forested Wetlands</b>	<b>Total wetlands</b>
Atlantic Ocean (Kings Cty)	Pathogens	0	2.7 (0.2%)	2.7
Coney Island Creek	Low dissolved oxygen, organic enrichment, pathogens	0	15.0 (1.1%)	15.0
East Rockaway Inlet	Pathogens	0	74.2 (5.2%)	74.2
Jamaica Bay (includes Bergen Basin, Hendrix Creek, Mill Basin, Paedegat Basin, Shellbank Basin)	Low dissolved oxygen, nitrogen, pathogens, organic enrichment	0	956.2 (67.2%)	956.2
Lower New York Bay	Pathogens, PCBs	0	185.2 (13.0%)	185.2
Ridders Pond*	Chlordane, pesticides	0	0	0
Sandy Hook Bay & Sandy Hook Reach	Fecal coliform, low dissolved oxygen, chromium, arsenic, copper, lead, mercury, silver, & zinc	0	46.5 (3.3%)	46.5
Other Wetlands	Not 303(d) listed	0	143.2 (10.1%)	143.2

\* No defined waterbody was found for Ridders Pond, only a section of Jamaica Bay was indicated by the EPA 303d listing

Table 9-4. Summary of long-term wetland and water quality monitoring programs within GATE. NPS: National Park Service; NY-DEC: New York Department of Environmental Conservation; NYC-DEP: New York City Department of Environmental Protection; USFWS: US Fish and Wildlife Service.

Monitoring Program	Time period	Agency	Data available
Fisheries Survey (Jamaica Bay)	1985 to present	NPS/USFWS	Fish species composition from trawls, gill nets, and beach seines
Tidal wetlands trends	1924 to 1999	NY-DEC	Historical trends in wetland area from maps and aerial photography. Maps available for 1924, 1974, 1994, and 1999
Water Quality	1981 to present	NPS	Total and fecal coliform as well as <i>Enterococcus</i> bacteria (Sandy Hook Unit); chlorophyll- <i>a</i> , conductivity, dissolved oxygen, water depths (Jamaica Bay only); nitrates, pH, phosphates, salinity, turbidity, and temperature (all units)
Water Quality	1909 to present	NYC-DEP	dissolved oxygen, fecal coliform, chlorophyll- <i>a</i> , and Secchi depth.

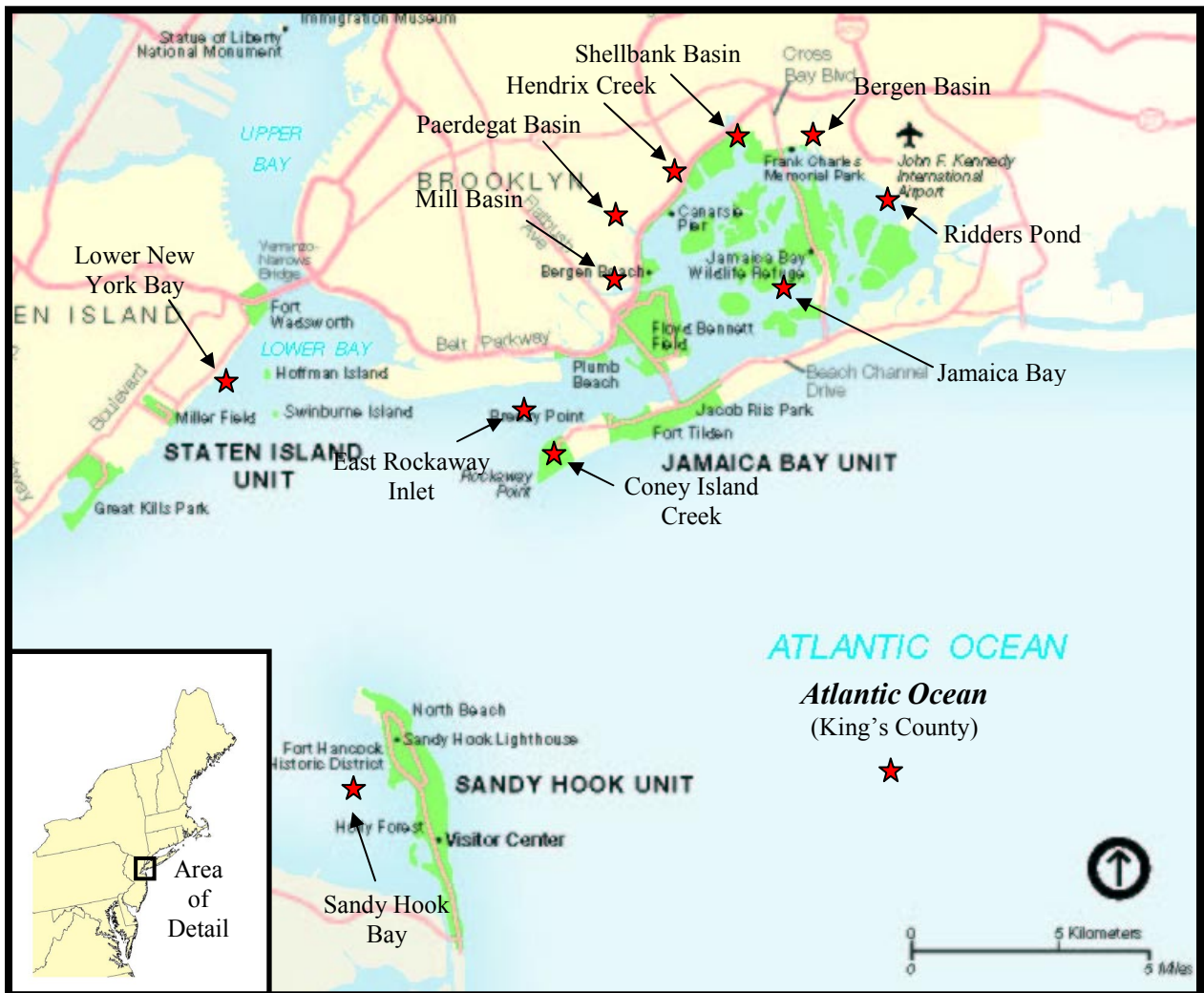


Figure 9-1. Map of Gateway National Recreation Area and surrounding waters. Stars indicate 303(d) listed waters.

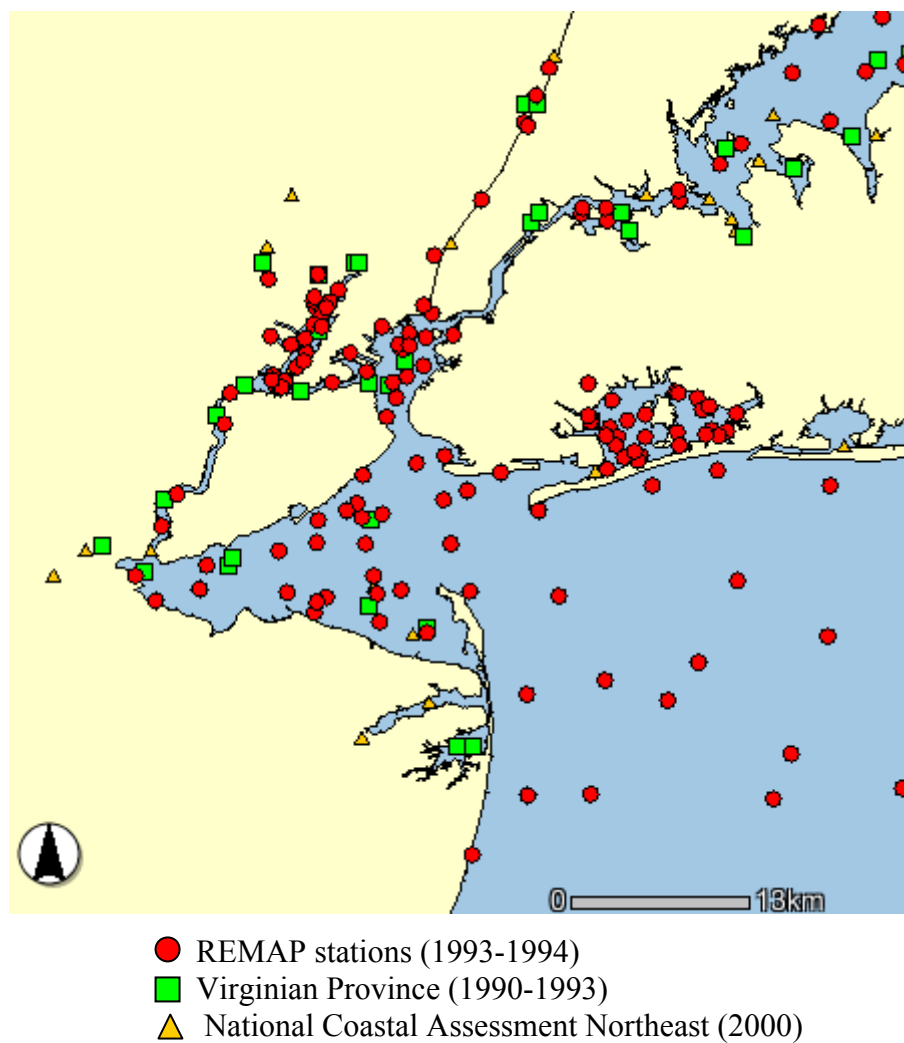


Figure 9-2. Map of sampling stations (and sampling years) for the Environmental Monitoring and Assessment Program (EMAP) surveys near GATE. Station data depicted above were produced by the U.S. Environmental Protection Agency through its EMAP Program, <http://www.epa.gov/emap>.

## **Chapter 10 - George Washington Birthplace National Monument**

### Water Quality

George Washington Birthplace National Monument (GEWA) is a 223 ha park located on the southern shore of the lower Potomac River (Maryland) that memorializes George Washington and the place of his birth. GEWA lies within the Chesapeake Bay ecosystem and includes Potomac River beach, upland forest, open fields, and marshlands along Popes Creek (Fig 10-1).

A summary of water quality for George Washington Birthplace National Monument (GEWA) is presented in Table 10-1. Information is a summary from EPA Water Quality Inventory 305(b), EPA TMDL 303(d) Reports, 2002 Virginia Department of Environmental Quality 303(d) Report, and Maryland 303(d) Report (MDE 2002; MD-DNR 2000; VA-DEQ 2002a, 2002b). The only waterbody within GEWA that is listed as impaired is Popes Creek which comprises 99% of the Park's waterbodies (Fig. 10-1). Popes Creek has a Virginia Department of Health shellfish restriction and is impaired by fecal coliform and pathogens resulting from point and non-point sources, and partially supports shellfishing and primary contact recreation. GEWA is also adjacent to the Potomac River which is impaired by organic enrichment, low dissolved oxygen, suspended sediment, and pathogens resulting from enrichment, natural, and non-point sources. The Potomac River has a fish consumption advisory in effect as it partially supports fish, shellfish, and wildlife protection and propagation.

### Outstanding Resource Waters

Maryland classifies Outstanding National Resource Waters (ONRW) as waters that are high quality waters that constitute an outstanding national resource, such as those waters of National and State parks, wildlife refuges, and waters of exceptional recreational and ecological significance (Code of Maryland Regulations website). As of this writing Maryland has not designated any ONRWs. Virginia classifies Outstanding Resource Waters as Significant Lakes. There are no Significant Lakes within GEWA.

### Wetland Area

Wetland classifications (based on National Wetlands Inventory data), total area (ha) and percent area for GEWA are shown in Table 10-2. GEWA has a total of 31.7 ha of wetlands, 18 ha (57%) of which are adjacent to impaired waterbodies (Table 10-3). There are only two waterbodies within or adjacent to GEWA that are 303(d) listed (Fig. 10-1). Wetlands adjacent to Popes Creek and the Potomac River compromise approximately 36% and 21%, respectively, of the total wetland area within GEWA. Due to the large tidal marsh areas in association with Popes Creek estuary complex an estimated 92% of the non-forested wetlands area within GEWA is influenced by this 303(d) listed waterbody (Table 10-3).

### Wetland and Water Quality Issues

*All Habitats and Waters*

Erosion along the Potomac River is severe and represents significant threats to GEWA (Kopp et al. 2002). Steep embankments, formed from poorly-drained silty sand and clay, along the river are 5-7m high and are currently eroding at the rate of 30-100 cm per year (Kopp et al. 2002). Land use practices are mainly agricultural and may represent other threats as park abutters raise cattle, which are allowed to wade in the creeks, and use bio-solids to fertilize their fields (Kopp et al. 2002). These farming practices most likely contribute to the fecal coliform and pathogen impairment of Popes Creek. However, sediment contaminant studies (organics and metals) indicate that Popes Creek is among the most pristine creeks in the Chesapeake (Kopp et al. 2002) and the site has been used as a reference location for numerous studies considering the effects of agricultural runoff on receiving waters and their geochemistry (Wilde et al. 2000). Competing pressures on parkland, such as encroaching land development within and outside of park boundaries, non-point source pollutants, proximity to point-source pollutants, natural processes (erosion), and future changes in land use are potential threats to the integrity of water quality and quantity at GEWA (USGS 2000).

Monitoring Programs (Table 10-4)*All Habitats and Waters*

Virginia Department of Environmental Quality (VA-DEQ) has water quality monitoring stations in and adjacent to Popes Creek. Station 1APOP000.38 is located within the Popes Creek Estuary (sampling was initiated at this station in February of 1997) and a suite of water quality parameters are monitored including: turbidity, conductivity, dissolved oxygen, pH, total suspended solids, ammonia, nitrite, nitrate, nitrogen, phosphorus, organic carbon, chloride, sulphate, sediment toxics, fecal coliform, and sediment particle size (VA DEQ 2002). Station 1APOP003.92 is located at the Route 3 bridge (sampling was initiated in April 1996). Water quality parameters monitored at this station include: total suspended solids, nitrogen, ammonia, nitrite and nitrate, phosphorus, pathogens, turbidity, and hardness (VA-DEQ 2002a). Additionally, two Potomac River water quality stations (station XDC1706 at the US Route 301 Bridge and station MLE2.2 at Ragged Point) in the vicinity of GEWA are monitored monthly by the Maryland Department of the Environment. A full suite of water quality parameters are monitored including: pH, temperature, chlorophyll-*a*, salinity, and Secchi depth. Phytoplankton community structure is examined monthly at a site upstream of GEWA at Indian Head (50 km away). Benthic community structure and sediment organic matter are monitored annually using both fixed station and probability based sampling throughout the Potomac River. None of these stations are directly adjacent to GEWA, but there are five stations within 20 km of GEWA (stations 43, 44, 51, and 52) (Kopp et al. 2002).

The National Park Service Water Resource Division and Servicewide Inventory and Monitoring Program conducted a baseline water quality data inventory and analysis of all surface waters (fresh, estuarine, and marine) for GEWA (NPS-WRD 1997b). Nine

stations were found within the study area, however only one station was located within the park's boundary. The technical report presents the results of surface-water-quality data retrievals for GEWA from five of the US EPA's national databases:

- Storage and Retrieval (STORET) database management system: Water quality parameter data, locations of sampling stations, descriptive elements about stations and parameters
- River Reach File (RF3): 1:100,000 scale geographical representation of surface waters (rivers, lakes, etc) with a unique identifier assigned to each surface water segment and connectivity information useful for routing and navigation.
- Industrial Facilities Discharge (IFD): Locations of industrial and municipal point source discharge facilities.
- Drinking Water Supplies (DRINKS): Locations of intake pipes for drinking water supplies.
- Stream Gages (GAGES): Locations of USGS and other discharge gages.

Provided within the GEWA technical reports are: 1. complete inventory of all retrieved water quality parameter data, water quality stations, and the entities responsible for data collection; 2. descriptive statistics and appropriate graphical plots of water quality data characterizing annual and seasonal central tendencies and trends; 3. a comparison of GEWA's water quality data relevant to EPA and WRD water quality screening criteria; 4. an Inventory Data Evaluation and Analysis (IDEA) to determine what Servicewide Inventory and Monitoring Program Level I water quality parameters have been measured within the study area. Level I water quality parameters identified by the Servicewide Inventory and Monitoring program were: alkalinity, pH, conductivity, dissolved oxygen, and rapid bioassessment baseline for fish and macroinvertebrates. Optional case-by-case parameters included toxic elements, clarity/turbidity, nitrate/nitrogen, phosphate/phosphorus, chlorophyll, sulfates, and bacteria (NPS-WRD 1997b). The results of the GEWA water quality screen found 11 parameters that exceeded screening criteria at least once within the study area. Dissolved oxygen, pH, chloride, cadmium, copper, and zinc exceeded their respective EPA criteria for the protection of freshwater aquatic life. Chloride, sulfate, cadmium, copper, and lead exceeded their respective EPA drinking water criteria. Bacteria concentrations (total coliform and fecal coliform) and turbidity exceeded the WRD screening limits for freshwater bathing and aquatic life, respectively (NPS-WRD 1997b).

The EPA's Environmental Monitoring and Assessment Program (EMAP) and the Mid-Atlantic Integrated Assessment (MAIA) monitor a variety of parameters within in the Potomac River adjacent to GEWA. There is one station in the Potomac River adjacent to GEWA (Fig. 10-2). Specific parameters that are monitored include (EPA EMAP website):

- Water quality: dissolved oxygen, salinity, temperature, depth, pH, nutrients, chlorophyll
- Sediment quality: grain size, total organic carbon, sediment chemistry, benthic community structure, sediment toxicity
- Biota: benthic community structure, fish community structure, fish external pathology, fish tissue analyses

GEWA was selected as one of the Northeast Coastal and Barrier Network Units to implement long-term monitoring protocols for salt marsh vegetation and estuarine nekton (Roman et al. 2001; Raposa & Roman 2001) developed at Cape Cod National Seashore for the Long-Term Monitoring Program. Monitoring will take place in the summer of 2005 within Pope's Creek marsh and/or Dancing Marsh. These data will serve as baseline data and it is hoped that the permanent stations will be sampled long-term.

The USGS maintains a National Water Information System (NWIS) water quality website, NWISweb Data for the Nation, where realtime data and archived data on surface water flow and levels in streams, lakes, springs, groundwater well levels, and water quality data from approximately 1.5 million stations nationwide can be queried (USGS 2004). There are 3 USGS stations adjacent to GEWA that have historical water quality data. Two stations are located at Popes Creek (USGS 0166087750 and USGS 0166087760) and the third is located at Dancing Marsh (USGS 0166087770). All have water quality data from 1998 to 1999.

The Alliance for Chesapeake Bay Citizen's Monitoring Program (ACBCMP) monitors water quality throughout Chesapeake Bay. One station is located within Popes Creek at GEWA (initiated in 1991), another is approximately 32 km upstream, and another is approximately 6.5 km downstream in the Potomac River. The ACBCMP conducts weekly summertime monitoring for temperature, salinity, pH, and dissolved oxygen (Kopp et al. 2002).

The VA Chesapeake Bay Program has monitored phytoplankton in the main stem of the Chesapeake Bay for nuisance/harmful species since 1985 (Kopp et al. 2002).

There has been a remote sensing program for chlorophyll-*a* throughout the Chesapeake Bay using Ocean Data Acquisition System satellite sensors since 1986, then SeaWiFS aircraft simulator (SASII) instruments since 1997. Mapping is incomplete in tributaries (Kopp et al. 2002).

#### *Other Monitoring Data Sources*

There is no NADP (National Atmospheric Deposition Program) station located within GEWA. The closest NAPD sites are MD13 in Wye, MD, and VA00 in Charlottesville, VA. An AIRMon (Atmospheric Integrated Research Monitoring Network) station (number MD15) is located on Smith Island in the main stem of the Chesapeake Bay.

Landuse and land cover data are available from the NOAA Coastal Change Analysis Program, and national land cover data are available from the Multi-resolution Land Characteristics Consortium from 1991 and 1992 imagery. National Wetlands Inventory Data, based on aerial photographs taken between 1970 and 1990, are also available.

Table 10-1. Water Quality Attainment Status for State Designated Uses [305(b) waters] and Impaired Waters [303(d) listed] for George Washington Birthplace National Monument. Percentages indicate percent of water body (from 305(b) listing) that is impaired. Information is a summary from EPA Water Quality Inventory 305(b), EPA TMDL 303(d) Reports, 2002 Virginia Department of Environmental Quality 303(d) Report, and Maryland 303(d) Report. If a 305(b) ID is not listed then the corresponding 305(b) report for that segment of the water body could not be found. None of these waterbodies had TMDL's reported to EPA by Virginia. VDH: Virginia Department of Health.

Waterbody	Listing Cycle	305 b Assessment Unit ID	303(d) List ID	Integrated List Category	Water Quality Attainment Status for State Designated Uses & Impairment
Popes Creek (Tidal limit to mouth of Potomac River)	2000	VAP-A31E_POP01A98	VAP-A31E_SF_E VAP-A31E-07 (Segment ID)	5	<b>Fully supports:</b> aquatic life, fish consumption <b>Partially supports:</b> shellfishing (100%), primary contact recreation. <b>Water Impairment:</b> fecal coliform, pathogens, VDH shellfish restriction <b>Source:</b> non-point & unknown sources
Popes Creek (Stream/Creek/River)	2000	VAP-A31R_POP01A00	Not listed	2	<b>Fully supports:</b> aquatic life, fish consumption <b>Not assessed:</b> primary contact recreation. <b>Water Impairment:</b> not 303(d) listed <b>Source:</b> not 303(d) listed
Potomac River/ Lower Potomac River Smith Point to mouth (tidal)	2002	MD-02140101-E-1_00 MD-02140101-E-1_01	MD-0103-02140101 MD-0015_021401	na	<b>Shellfishing:</b> Portion of River is restricted (<0.76 sq mi) and conditionally approved (2.58 sq mi) due to waste water discharge safety zone (not a water impairment), and non-point runoff <b>Fish consumption advisory</b> <b>Partially supports:</b> fish, shellfish, and wildlife protection and propagation (100%). <b>Water Impairment:</b> organic enrichment/low dissolved oxygen, suspended sediment, pathogens, nutrients, toxics (PCBs) <b>Source:</b> eutrophication, natural sources, & non-point sources

**Fish consumption advisory:** Advisory issued in April 1999 for PCBs in channel catfish, American eel, and carp in the Lower Potomac River. Source of PCB's probably are residues from disposal of electrical transformers, although no specific source is identified (MD-DNR 2000).

Website addresses:

EPA Water Quality Inventory 305(b) website: <http://www.epa.gov/waters/305b/index.html>

EPA TMDL 303(d) Reports: <http://www.epa.gov/waters/tmdl/index.html>

Virginia Department of Environmental Quality 2002 303(d) Report: <http://www.deq.state.va.us/water/303d.html>

Maryland's 2002 303(d) List: <http://www.mde.state.md.us/Programs/WaterPrograms/TMDL/Maryland%20303%20dlist/index.asp>

Maryland's 2000 305(b) Report: [http://dnrweb.dnr.state.md.us/download/bays/MD2000\\_305b.pdf](http://dnrweb.dnr.state.md.us/download/bays/MD2000_305b.pdf)

Table 10-2. Vegetation classification (wetland), total hectares, and percent of total area for GEWA. Areas calculated from National Wetlands Inventory (NWI) GIS coverages.

NWI code	Description	Total hectares	Percent of total area
<b>Water</b>			
E1UBL	Estuarine, Subtidal, Unconsolidated Bottom, Subtidal	8.1	3.5%
E1UBL6	Estuarine, Subtidal, Unconsolidated Bottom, Subtidal, Oligohaline	0.4	0.2%
E2US2P	Estuarine, Intertidal, Unconsolidated Shore, Sand, Irregularly Flooded	2.4	1.0%
PUBH	Palustrine, Unconsolidated Bottom, Permanently Flooded	2.4	1.0%
PUBHh	Palustrine, Unconsolidated Bottom, Permanently Flooded, Diked/Impounded	0.2	0.1%
PUBHhx	Palustrine, Unconsolidated Bottom, Permanently Flooded, Diked/Impounded, Excavated	0.2	0.1%
<b>Upland</b>			
U	Upland	185.8	80.3%
<b>Non-forested Wetland</b>			
E2EM1P	Estuarine, Intertidal, Emergent, Persistent, Irregularly Flooded	6.5	2.8%
E2EM1P6	Estuarine, Intertidal, Emergent, Persistent, Irregularly Flooded, Oligohaline	1.0	0.4%
E2SS1P	Estuarine, Intertidal, Scrub-Shrub, Broad-Leaved Deciduous, Irregularly Flooded	4.9	2.1%
PEM1A	Palustrine, Emergent, Persistent, Temporarily Flooded	0.5	0.2%
PEM1B	Palustrine, Emergent, Persistent, Saturated	1.3	0.6%
PEM1R	Palustrine, Emergent, Persistent, Seasonal-Tidal	0.4	0.2%
<b>Forested wetland</b>			
PFO1/4B	Palustrine, Forested, Broad-Leaved Deciduous/Forested, Needle-Leaved Evergreen, Saturated	2.3	1.0%
PFO1/SS1R	Palustrine, Forested, Broad-Leaved Deciduous/Scrub-Shrub, Broad-Leaved Deciduous, Seasonal-Tidal	4.5	1.9%
PFO1A	Palustrine, Forested, Broad-Leaved Deciduous, Temporarily Flooded	0.0	0.0%
PFO1C	Palustrine, Forested, Broad-Leaved Deciduous, Seasonally Flooded	0.1	0.0%
PFO1Ch	Palustrine, Forested, Broad-Leaved Deciduous, Seasonally Flooded, Diked/Impounded	0.1	0.0%
PFO1R	Palustrine, Forested, Broad-Leaved Deciduous, Seasonal-Tidal	2.2	1.0%
PFO1S	Palustrine, Forested, Broad-Leaved Deciduous, Temporary-Tidal	5.6	2.4%

<b>NWI code</b>	<b>Description</b>	<b>Total hectares</b>	<b>Percent of total area</b>
PFO4S	Palustrine, Forested, Needle-Leaved Evergreen, Temporary-Tidal	0.2	0.1%
PSS1/FO1R	Palustrine, Scrub-Shrub, Broad-Leaved Deciduous/Forested, Broad-Leaved Deciduous, Seasonal-Tidal	0.4	0.2%
PSS1B	Palustrine, Scrub-Shrub, Broad-Leaved Deciduous, Saturated	0.1	0.0%
PSS1C	Palustrine, Scrub-Shrub, Broad-Leaved Deciduous, Seasonally Flooded	0.4	0.2%
PSS1F	Palustrine, Scrub-Shrub, Broad-Leaved Deciduous, Semipermanently Flooded	1.2	0.5%

Table 10-3. Total hectares (and percent of wetland type) of wetlands adjacent to 303(d) listed waterbodies within GEWA. Note: VDH: Virginia Department of Health. Impaired forested wetlands are National Wetlands Inventory (NWI) codes: PFO1R, PFO1S, & PSS1F; impaired non-forested wetlands are NWI codes: E2EM1P & E2SS1P. Areas calculated from NWI GIS coverages.

<b>Waterbody</b>	<b>Impairment</b>	<b>Forested wetlands</b>	<b>Non-forested Wetlands</b>	<b>Total wetlands</b>
Popes Creek	Fecal coliform, pathogens, VDH shellfish restriction	0	11.4 (36.0%)	11.4
Potomac River	Organic enrichment, low dissolved oxygen, suspended sediment, pathogens, nutrients, PCBs	6.7 (21.1%)	0	6.7
Other wetlands	Not 303(d) listed	12.6 (39.7%)	1.0 (3.2%)	13.6

Table 10-4. Summary of long-term wetland and water quality monitoring programs within GEWA. ACBCMP: Alliance for Chesapeake Bay Citizen's Monitoring Program; VA-DEQ: Virginia Department of Environmental Quality.

<b>Monitoring Program</b>	<b>Time period</b>	<b>Agency</b>	<b>Data available</b>
Water quality (Popes Creek Estuary)	1997 to present	VA-DEQ	Turbidity, conductivity, dissolved oxygen, pH, total suspended solids, ammonia, nitrite, nitrate, nitrogen, phosphorus, organic carbon, chloride, sulphate, sediment toxics, fecal coliform, and sediment particle size
Water quality (Popes Creek)	1991 to present (summertime only)	ACBCMP	Temperature, salinity, pH, and dissolved oxygen.

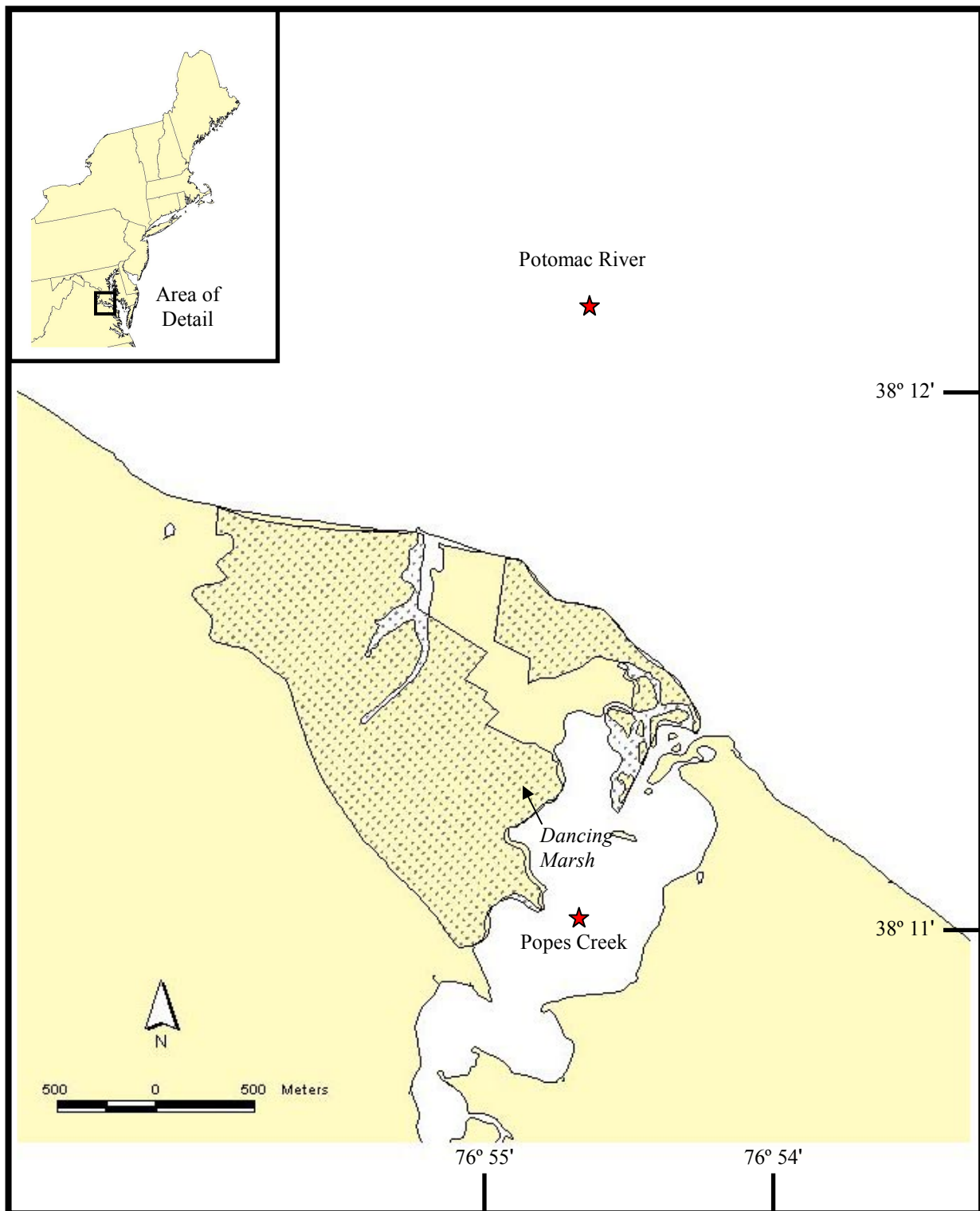


Figure 10-1. Map of George Washington Birthplace National Historic Site and surrounding waters. Shaded areas indicated Park Lands. Stars indicate 303(d) listed waters.

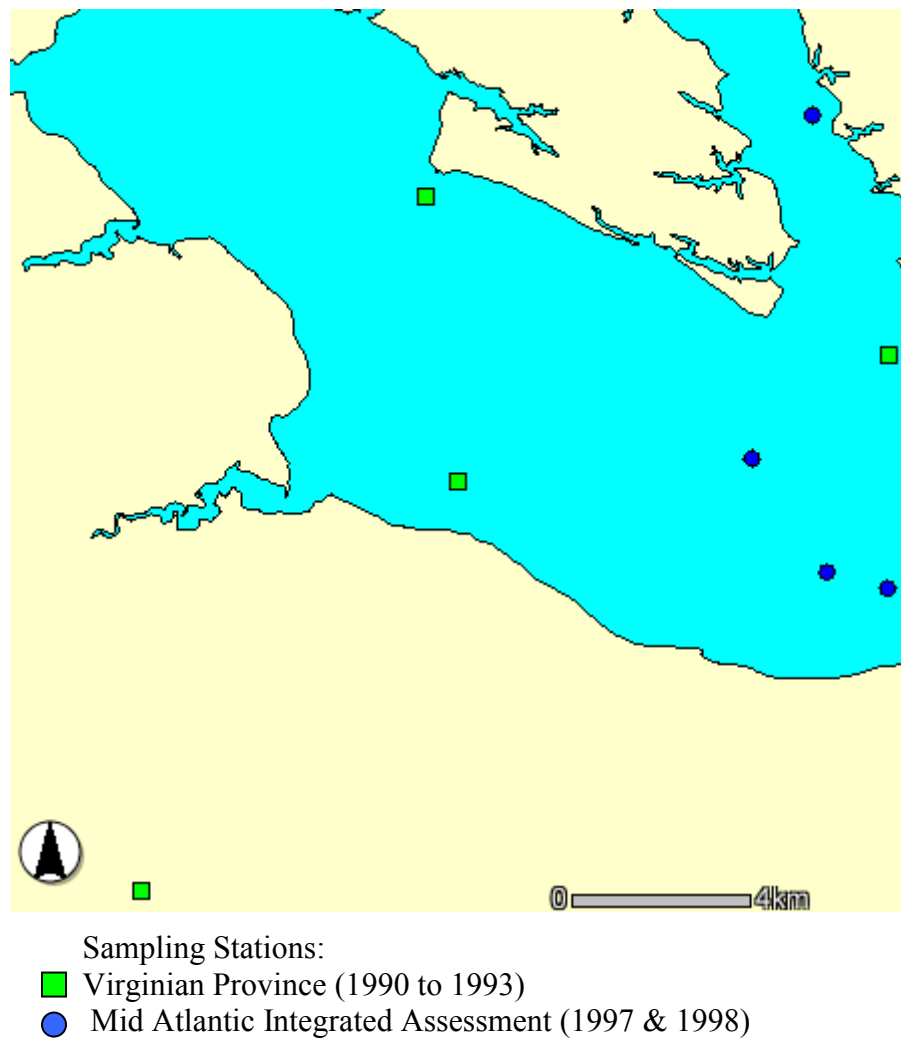


Figure 10-2. Map of sampling stations (and sampling years) for the Environmental Monitoring and Assessment Program (EMAP) surveys near GEWA. Station data depicted above were produced by the U.S. Environmental Protection Agency through its EMAP Program, <http://www.epa.gov/emap>.

## **Chapter 11 - Sagamore Hill National Historic Site**

### Water Quality

Sagamore Hill National Historic Site (SAHI) is a small (33.5 ha) cultural and historic park encompassing Theodore Roosevelt's farm and gardens on Cold Spring Harbor, on the north shore of Long Island, NY. Wetland areas include a small marsh that lies adjacent to Cold Spring Harbor, and a small freshwater pond (Fig 11-1).

A summary of water quality for Sagamore Hill National Historic Site is presented in Table 11-1. Information is a summary from EPA Water Quality Inventory 305(b), EPA TMDL 303(d) Reports, 2000 New York State Water Quality 305(b) Report, and the New York 2002 303(d) List (NY-DEC 2000). Cold Spring Harbor is the only listed waterbody adjacent to SAHI. The impairments to Cold Spring Harbor are pathogens and PCBs in migratory fish species from urban and storm runoff (Table 11-1). The designated uses of shellfishing and fish consumption are not supporting by Cold Spring Harbor waters.

### Outstanding Resource Waters

Information on Outstanding Resource Waters could not be found for the state of New York.

### Wetland Area

There is one, small (1.8 ha) salt marsh wetland fed by a tidal creek that receives water from Cold Spring Harbor (Fig. 11-1, Table 11-2). Since this wetland receives tidal waters from Cold Spring Harbor it is most likely influenced by the same impairments (pathogens and PCBs in migratory fish species) (Table 11-3). There is also a small (0.1 ha) pond within SAHI. No water quality information could be found for this pond.

### Wetland and Water Quality Issues

#### *All Habitats and Waters*

Landuse that directly impacts the small salt marsh at SAHI is primarily from the Park itself and a few large neighboring estates (Kopp et al. 2002). The impairments of Cold Spring Harbor potentially impact the small salt marsh within SAHI.

Dissolved oxygen appears to be a problem for Cold Spring Harbor, as Friends of the Bay (FOB) monitoring during the summer of 2000 revealed dissolved oxygen concentrations that did not meet the New York State minimum standard of 5.0 mg/l for Class SC waters, the lowest classification suitable for primary contact recreation (swimming) (Kopp et al 2002). New York and Connecticut have identified Long Island Sound as "water quality limited" due to hypoxia (Kopp et al. 2002).

### Monitoring Programs (Table 11-4)

#### *All Habitats and Waters*

Friends of the Bay (FOB), a local volunteer-based environmental organization located in Oyster Bay, NY, have a water quality program (developed in cooperation with the EPA, NY Department of Environmental Conservation, and local governments) that monitors various water quality parameters on a weekly basis since 1999 (temperature, Secchi disk depth, salinity, dissolved oxygen, coliform bacteria) from May through October at six sites throughout Oyster Bay and Cold Spring Harbor (2 sites are within Cold Spring Harbor) (Friends of the Bay website; Kopp et al. 2002).

SAHI was selected as one of the Northeast Coastal and Barrier Network Units to implement long-term monitoring protocols for salt marsh vegetation and estuarine nekton (Roman et al. 2001; Raposa & Roman 2001) developed at Cape Cod National Seashore for the Long-Term Monitoring Program. Salt marsh vegetation and nekton monitoring were conducted in the summer of 2004 on the small salt marsh adjacent to Cold Spring Harbor (James-Pirri, University of Rhode Island, unpublished data). These data will serve as baseline data and it is hoped that the site will be sampled long-term.

The National Park Service Water Resource Division and Servicewide Inventory and Monitoring Program conducted a baseline water quality data inventory and analysis of all surface waters (fresh, estuarine, and marine) for SAHI (NPS-WRD 1998a). No stations were located within the park's boundary, but stations were monitored in Oyster Bay, and Cold Spring Harbor. The technical report presents the results of surface-water-quality data retrievals for SAHI from five of the US EPA's national databases:

- Storage and Retrieval (STORET) database management system: Water quality parameter data, locations of sampling stations, descriptive elements about stations and parameters
- River Reach File (RF3): 1:100,000 scale geographical representation of surface waters (rivers, lakes, etc) with a unique identifier assigned to each surface water segment and connectivity information useful for routing and navigation.
- Industrial Facilities Discharge (IFD): Locations of industrial and municipal point source discharge facilities.
- Drinking Water Supplies (DRINKS): Locations of intake pipes for drinking water supplies.
- Stream Gages (GAGES): Locations of USGS and other discharge gages.

Provided within the SAHI technical reports are: 1. complete inventory of all retrieved water quality parameter data, water quality stations, and the entities responsible for data collection; 2. descriptive statistics and appropriate graphical plots of water quality data characterizing annual and seasonal central tendencies and trends; 3. a comparison of SAHI's water quality data relevant to EPA and WRD water quality screening criteria; 4. an Inventory Data Evaluation and Analysis (IDEA) to determine what Servicewide Inventory and Monitoring Program Level I water quality parameters have been measured within the study area. Level I water quality parameters identified by the Servicewide

Inventory and Monitoring program were: alkalinity, pH, conductivity, dissolved oxygen, and rapid bioassessment baseline for fish and macroinvertebrates. Optional case-by-case parameters included toxic elements, clarity/turbidity, nitrate/nitrogen, phosphate/phosphorus, chlorophyll, sulfates, and bacteria (NPS-WRD 1998a). The results of the SAHI water quality criteria screen for Oyster bay and Cold Spring Harbor found ten parameters that exceeded screening criteria at least once within the study area. Dissolved oxygen, pH, chloride, and copper exceeded their respective EPA criteria for the protection of freshwater aquatic life. Copper, silver, zinc, and pH exceeded their respective EPA criteria for the protection of marine aquatic life. Chloride, sulfate, and nitrate respective EPA drinking water criteria. Fecal-indicator bacteria concentrations (fecal coliform and total coliform) exceeded the WRD screening limits for freshwater and marine bathing (NPS-WRD 1998a).

The EPA's National Coastal Assessment, also known as Coastal 2000, the Regional Environmental Monitoring and Assessment Program (REMAP), and the Environmental Monitoring and Assessment Program (EMAP) monitor a variety of parameters within Long Island Sound. One station within Cold Spring Harbor was sampled in 2000 (Fig. 11-2). Specific parameters that are monitored include (Coastal 2000; EPA EMAP website):

- Water quality: dissolved oxygen, salinity, temperature, depth, pH, nutrients, chlorophyll
- Sediment quality: grain size, total organic carbon, sediment chemistry, benthic community structure, sediment toxicity
- Biota: benthic community structure, fish community structure, fish external pathology, fish tissue analyses

Suffolk County Department of Health used to have an extensive monitoring program (initiated in 1976), but it was severely cut back in 1998 (Kopp et al. 2002; Suffolk County Department of Health website). Previous to 1998, monitoring had included a full suite of nitrogen and phosphorus nutrient analyses, dissolved oxygen, chlorophyll-a, *Aureococcus*, Secchi depth, temperature, salinity, total suspended solids, total organic carbon, dissolved organic carbon, and bacteriological monitoring. Cutbacks by the county in 1998 were the instigating factor prompting Friends of the Bay to initiate water quality monitoring (Kopp et al. 2002).

Interstate Environmental Commission (IEC), formerly the Interstate Sanitation Commission, representing NY, NJ and CT, monitors 67 stations (33 of which are long term) in New York/New Jersey Harbor and Long Island Sound biweekly during the summer and monthly during the rest of the year. Parameters measured include temperature, salinity, dissolved oxygen, chlorophyll-a, turbidity, organic carbon, and a suite of nitrogen and phosphorus nutrient analyses. In 2003, water quality samples were collected for *Pfiesteria*, a toxic dinoflagellate. There are no stations in Oyster Bay or Cold Spring Harbor, but there are representative stations for Western Long Island Sound (IEC 2003).

#### *Other Monitoring Data Sources*

There is no NADP (National Atmospheric Deposition Program) station located near SAHI. The closest NADP sites are at West Point, NY (NY99) and Southhold NY (NY96). However, NY-DEC maintains an atmospheric deposition monitoring site at Hempstead (Nassau County) since 1987 (Eisenhower Park station #2950-10) and at the New York Botanical Gardens in the Bronx since 2000 (Botanical Gardens station #7094-06) (NY-DEC website).

Landuse and land cover data are available from the NOAA Coastal Change Analysis Program, and national land cover data are available from the Multi-resolution Land Characteristics Consortium from 1991 and 1992 imagery. Vegetation maps are available from National Wetlands Inventory Data (based on aerial photographs taken between 1970 and 1990) and the New York Natural Heritage Program.

Table 11-1. Water Quality Attainment Status for State Designated Uses [305(b) waters] and Impaired Waters [303(d) listed] for Sagamore Hill National Historic Site. Percentages indicate percent of water body (from 305(b) listing) that is impaired. Information is a summary from EPA Water Quality Inventory 305(b), EPA TMDL 303(d) Reports, 2000 New York State Water Quality 305(b) Report (which also lists the 1998 303(d) list), and the New York 2002 303(d) List. New York has not submitted detailed electronic water quality assessment data in standard format to EPA at this time therefore 305(b) Assessment Unit IDs are not available at this time. “na” indicates information could not be found

Waterbody	Listing Cycle	305 b Assessment Unit ID	303(d) List ID	Integrated List Category or Class	Water Quality Attainment Status for State Designated Uses & Impairment
Cold Spring Harbor	2002	Not listed	NY-1702-0018	na, SA	<b>Precluded:</b> shellfishing, fish consumption <b>Water Impairment:</b> pathogens, PCBs in migratory species <b>Source:</b> urban & storm runoff

Website addresses:

EPA Water Quality Inventory 305(b) website: <http://www.epa.gov/waters/305b/index.html>

EPA TMDL 303(d) Reports: <http://www.epa.gov/waters/tmdl/index.html>

2000 New York State Water Quality Report (which also lists the 1998 303(d) list: <http://www.dec.state.ny.us/website/dow/305b00.pdf>

New York 2002 303(d) List: <http://www.dec.state.ny.us/website/dow/303dlist.pdf>

Table 11-2. Vegetation classification, total hectares, and percent of total area for SAHI. Areas calculated from SAHI GIS coverages (draft maps from NY Natural Heritage).

<b>Vegetation Classification</b>	<b>Total hectares</b>	<b>Percent of Total Area</b>
Water		
Pond	0.115	0.3%
Tidal Creek	0.663	1.9%
Upland		
Beech-maple mesic forest	13.672	38.2%
Developed	10.586	29.5%
Maritime Beach	0.943	2.6%
Maritime Dunes	0.993	2.8%
Norway Maple + Succ. Exotics	4.473	12.5%
Norway maple forest	2.858	8.0%
Non-forested Wetland		
Brackish Interdunal Swales	0.218	0.6%
Low Salt Marsh/Salt Panne Comp	1.304	3.6%

Table 11-3. Total hectares of wetlands adjacent to 303(d) listed waterbodies within SAHI. Areas calculated from SAHI GIS coverages (draft maps from NY Natural Heritage).

<b>Waterbody</b>	<b>Impairment</b>	<b>Forested wetlands</b>	<b>Non-forested Wetlands</b>	<b>Total wetlands</b>
Cold Spring Harbor	Pathogens, PCBs in migratory species	0	1.5 (100%)	1.5
Other wetlands	Not 303(d) listed	0	0	0

Table 11-4. Summary of long-term wetland and water quality monitoring programs adjacent to SAHI. FOB: Friends of the Bay. SCDOH: Suffolk County Department of Health.

Monitoring Program	Time period	Agency	Data available
Water quality	1999 to present	FOB	Temperature, Secchi disk depth, salinity, dissolved oxygen, coliform bacteria
Water quality	1976-1998	SCDOH	Nitrogen and phosphorus nutrient analyses, dissolved oxygen, chlorophyll-a, <i>Aureococcus</i> , Secchi depth, temperature, salinity, total suspended solids, total organic carbon, dissolved organic carbon, and bacteriological monitoring.

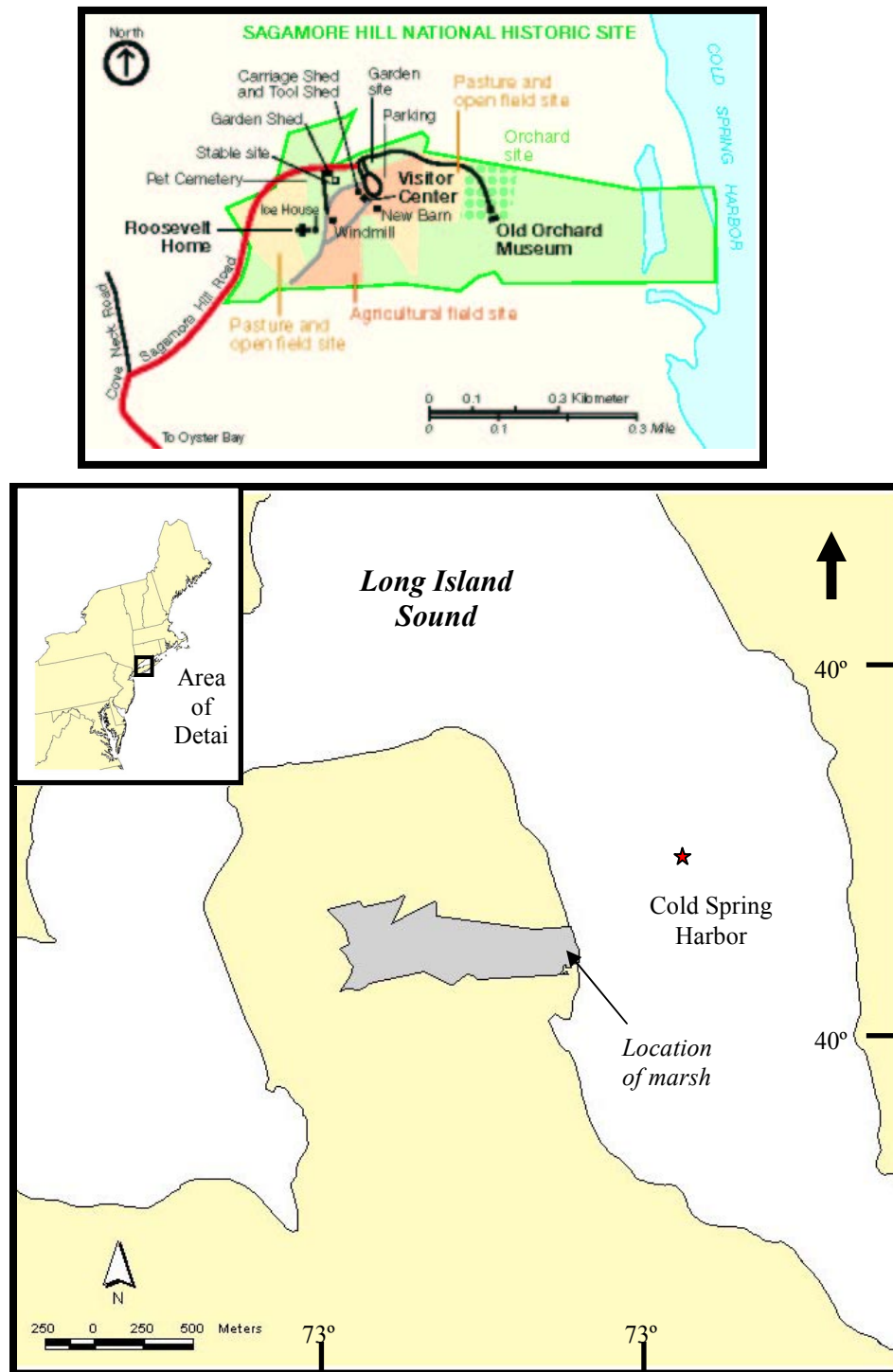


Figure 11-1. Map of Sagamore Hill National Historic Site and surrounding waters. Shaded area indicates Park Land. Stars indicate 303(d) listed waters.

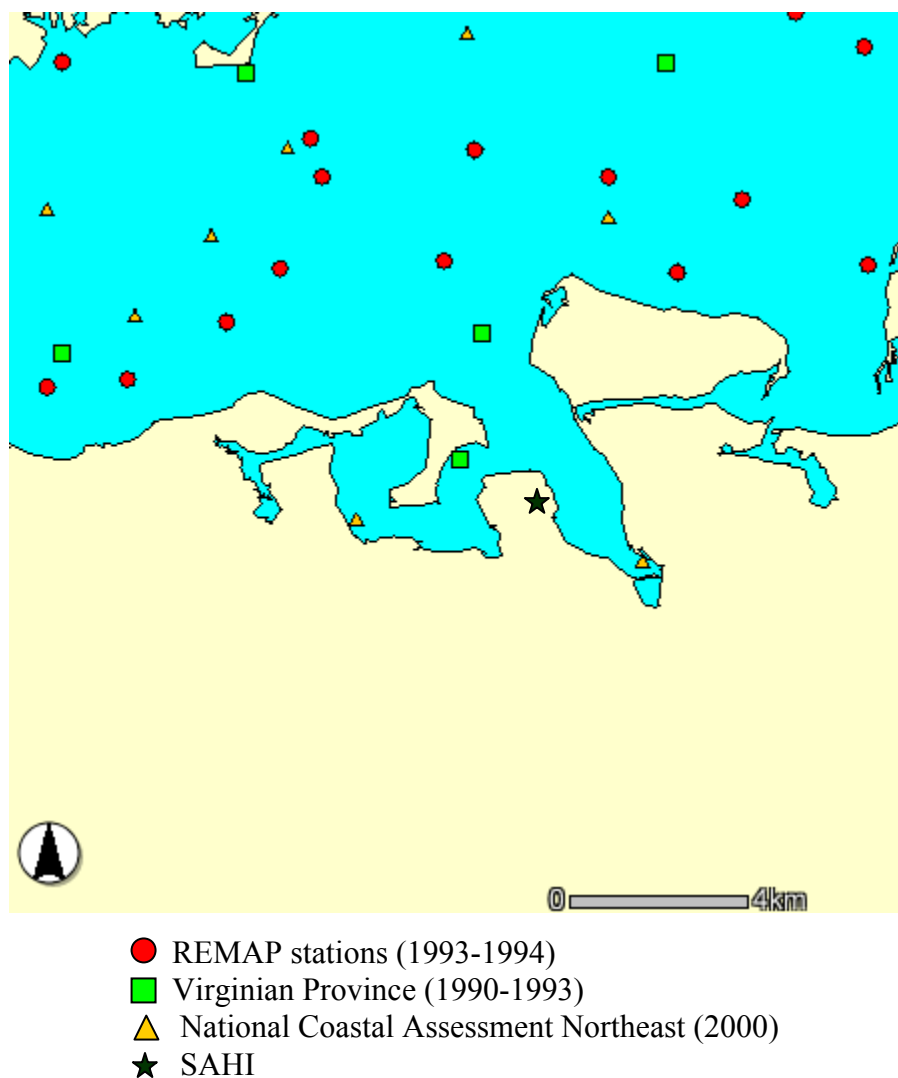


Figure 11-2. Map of sampling stations (and sampling years) for the Environmental Monitoring and Assessment Program (EMAP) surveys near SAHI. Station data depicted above were produced by the U.S. Environmental Protection Agency through its EMAP Program, <http://www.epa.gov/emap>.

## **Chapter 12 - Thomas Stone National Historic Site**

### Water Quality

Thomas Stone National Historic Site (THST) memorializes the home (Habre-de-Venture) of Thomas Stone, a signer of the Declaration of Independence, near Port Tobacco, Maryland. Wetland areas within THST include a few small unnamed ponds and streams.

A summary of water quality for Thomas Stone National Historic Site is presented in Table 12-1. Information is a summary from EPA Water Quality Inventory 305(b), EPA TMDL 303(d) Reports, and Maryland 303(d) Report (MDE 2002; MD-DNR 2000). There are only a few small unnamed ponds and streams within THST, none of which are listed as assessed or impaired. The Port Tobacco River, which is approximately 1.5km from the Park (Fig. 12-1), is impaired by nutrients from non-point and natural sources, but the non-tidal portion of the river is not 303(d) listed and no designated uses are impaired for this portion of the river.

The Port Tobacco River watershed is listed as a Category 1 and Category 3 watershed by the Maryland Clean Water Action Plan [Clean Water Action Plan Technical Workgroup (CWAPTW) 1998)]. Category 1 watersheds are defined as those watersheds not meeting clean water and other natural resource goals and needing restoration. Category 3 watersheds are pristine or sensitive watersheds that are in need of extra protection. Many of Maryland's watersheds are listed as both Category 1 and 3 (CWAPTW 1998).

### Outstanding Resource Waters

Maryland classifies Outstanding National Resource Waters (ONRW) as waters that are high quality waters that constitute an outstanding national resource, such as those waters of national and State parks, wildlife refuges, and waters of exceptional recreational and ecological significance (Code of Maryland Regulations website). As of this writing Maryland has not designated any ONRW.

### Wetland Area

There are no wetlands within THST, only two small ponds (Table 12-2).

### Wetland and Water Quality Issues

#### *All Habitats and Waters*

There are no known water quality issues for THST.

### Monitoring Programs

#### *All Habitats and Waters*

There are no long-term wetland or water quality monitoring programs at THST.

The National Park Service Water Resource Division and Servicewide Inventory and Monitoring Program conducted a baseline water quality data inventory and analysis of all surface waters (fresh, estuarine, and marine) for THST (NPS-WRD 1998b). No water quality monitoring stations were located within the park's boundary, as most observations were from one station located in Port Tobacco Creek. The technical report presents the results of surface-water-quality data retrievals for THST from five of the US EPA's national databases:

- Storage and Retrieval (STORET) database management system: Water quality parameter data, locations of sampling stations, descriptive elements about stations and parameters
- River Reach File (RF3): 1:100,000 scale geographical representation of surface waters (rivers, lakes, etc) with a unique identifier assigned to each surface water segment and connectivity information useful for routing and navigation.
- Industrial Facilities Discharge (IFD): Locations of industrial and municipal point source discharge facilities.
- Drinking Water Supplies (DRINKS): Locations of intake pipes for drinking water supplies.
- Stream Gages (GAGES): Locations of USGS and other discharge gages.

Provided within the THST technical reports are: 1. complete inventory of all retrieved water quality parameter data, water quality stations, and the entities responsible for data collection; 2. descriptive statistics and appropriate graphical plots of water quality data characterizing annual and seasonal central tendencies and trends; 3. a comparison of THST's water quality data relevant to EPA and WRD water quality screening criteria; 4. an Inventory Data Evaluation and Analysis (IDEA) to determine what Servicewide Inventory and Monitoring Program Level I water quality parameters have been measured within the study area. Level I water quality parameters identified by the Servicewide Inventory and Monitoring program were: alkalinity, pH, conductivity, dissolved oxygen, and rapid bioassessment baseline for fish and macroinvertebrates. Optional case-by-case parameters included toxic elements, clarity/turbidity, nitrate/nitrogen, phosphate/phosphorus, chlorophyll, sulfates, and bacteria (NPS-WRD 1998b). The results of the THST water quality criteria screen (most data were from the Popes Creek Station) found four parameters that exceeded screening criteria at least once within the study area. The EPA criteria for the protection of freshwater aquatic life was exceeded by pH. Fecal-indicator bacteria concentrations (total coliform and fecal coliform) and turbidity exceeded the WRD screening limits for freshwater bathing and aquatic life, respectively (NPS-WRD 1998b).

The US EPA's the Environmental Monitoring and Assessment Program (EMAP) monitor a variety of parameters within Tobacco Creek (Fig 12-2). Specific parameters that are monitored include (EPA EMAP website):

- Water quality: dissolved oxygen, salinity, temperature, depth, pH, nutrients, chlorophyll

- Sediment quality: grain size, total organic carbon, sediment chemistry, benthic community structure, sediment toxicity
- Biota: benthic community structure, fish community structure, fish external pathology, fish tissue analyses

*Other Monitoring Data Sources*

There is no NADP (National Atmospheric Deposition Program) station located within THST. The closest NAPD sites are MD13 in Wye, MD, and VA00 in Charlottesville, VA. An AIRMon (Atmospheric Integrated Research Monitoring Network) station (number MD15) is located on Smith Island in the main stem of the Chesapeake Bay.

National Wetlands Inventory Data, based on aerial photographs taken between 1970 and 1990, are available.

Table 12-1. Water Quality Attainment Status for State Designated Uses [305(b) waters] and Impaired Waters [303(d) listed] for Thomas Stone National Historic Site. Percentages indicate percent of water body (from 305(b) listing) that is impaired. Information is a summary from EPA Water Quality Inventory 305(b), EPA TMDL 303(d) Reports, and Maryland 303(d) Report. If a 305(b) ID is not listed than the corresponding 305(b) report for that segment of the water body could not be found. \* A TMDL for nitrogen and phosphorus was approved by the EPA on 3/18/99 for this waterbody.

Waterbody	Listing Cycle	305 b Assessment Unit ID	303(d) List ID	Integrated List Category	Water Quality Attainment Status for State Designated Uses & Impairment
Port Tobacco River	2000	MD-02140109-R-1_0773	Not Listed	na	<b>Fully Supporting:</b> Fish, shellfish, and wildlife protection and propagation. <b>Water Impairment:</b> nutrients <b>Source:</b> Point, non-point, and natural
Port Tobacco River (tidal) *	2002	MD-02140109-E-1_00	MD-0111-02140109	na	<b>Partially Supporting:</b> Fish, shellfish, and wildlife protection and propagation (100%). <b>Water Impairment:</b> nutrients (nitrogen & phosphorus), suspended sediment <b>Source:</b> Municipal point sources, non-point source, agriculture, urban runoff/storm sewers

Website addresses:

EPA Water Quality Inventory 305(b) website: <http://www.epa.gov/waters/305b/index.html>

EPA TMDL 303(d) Reports: <http://www.epa.gov/waters/tmdl/index.html>

Maryland's 2002 303(d) List: <http://www.mde.state.md.us/Programs/WaterPrograms/TMDL/Maryland%20303%20dlist/index.asp>

Maryland's 2000 305(b) Report: [http://dnrweb.dnr.state.md.us/download/bays/MD2000\\_305b.pdf](http://dnrweb.dnr.state.md.us/download/bays/MD2000_305b.pdf)

Table 12-2. Vegetation classification, total hectares, and percent of total area for THST. Areas calculated from National Wetlands Inventory (NWI) GIS coverages and THST GIS coverages.

<b>NWI code</b>	<b>Description</b>	<b>Total hectares</b>	<b>Percent</b>
U	Upland	128.8	99.9%
PUBHh	Palustrine, Unconsolidated Bottom, Permanently Flooded, Diked/Impounded	0.1	0.1%

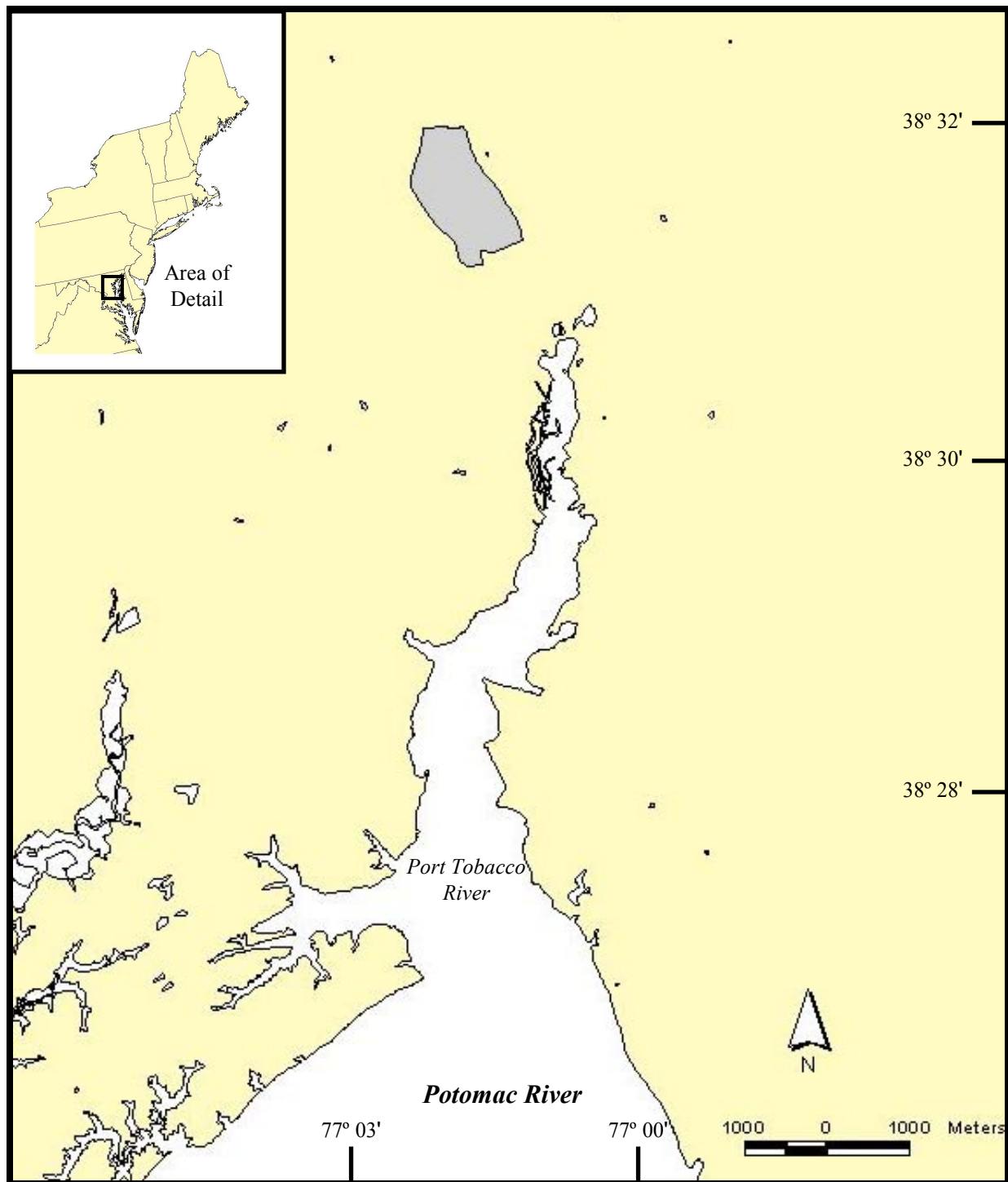


Figure 12-1. Map of Thomas Stone National Historic Site and surrounding waters. Shaded area indicates Park Land.

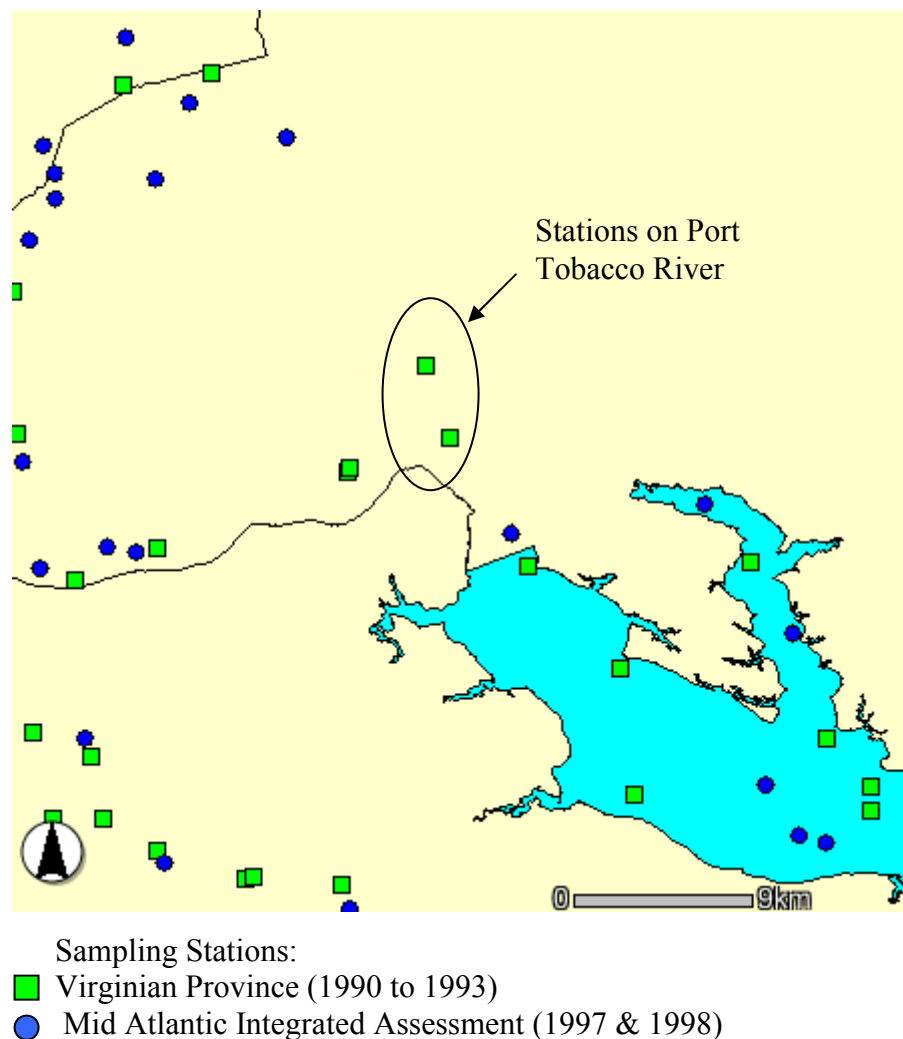


Figure 12-2. Map of sampling stations (and sampling years) for the Environmental Monitoring and Assessment Program (EMAP) surveys near THST. Station data depicted above were produced by the U.S. Environmental Protection Agency through its EMAP Program, <http://www.epa.gov/emap>.

## **Chapter 13 - Synthesis of Northeast Coastal and Barrier Network Water Quality**

### 305(b) and 303(d) Water Impairments

A summary of 305(b) and 303(d) water quality impairments for the Northeast Coastal and Barrier Network (NCBN) are shown in Table 13-1 (THST is not included because there are no assessed wetlands or waterbodies within the park unit). Note that Table 13-1 lists only documented impairments as identified by States in their 305(b) and 303(d) Reports to the EPA. The most common impairments, present at all park units investigated, were pathogens, including bacteria and/or fecal coliform and restrictions on shellfishing. The next most common water quality impairment were fish consumption advisories which were present at 7 park units (ACAD, BOHA, CACO, COLO, GATE, GEWA, SAHI). Dissolved oxygen, nutrients, organic enrichment (all present at ASIS, CACO, COLO, GATE, and GEWA) and PCBs (present at ACAD, COLO, GATE, GEWA, SAHI) were impairments at 5 park units. Impairments due to toxics and or metals were found at 4 units (ACAD, BOHA, CACO, and GATE). Turbidity is an impairment at 2 units (BOHA and GEWA). Other impairments present at 1 unit were acidity (CACO), benthic standard (COLO), sedimentation (COLO), suspended solids (BOHA), and trash/debris (BOHA).

COLO had the highest number of listed impairments (9) of the parks investigated (Table 13-1). CACO, GATE, and GEWA each had 8 listed impairments, while BOHA had 7 impairments. Five impairments were listed for ACAD and ASIS, while SAHI had 4, and FIIS had 2 listed impairments (Table 13-1).

### Sources of Impairments

A summary of sources of impairments for 305(b) and 303(d) listed waters are presented in Table 13-2. Note that Table 13-2 lists only documented impairments as identified by States in their 305(b) and 303(d) Reports to the EPA. The most striking point of this table is that for six (ACAD, BOHA, CACO, COLO, GATE, and GEWA) of the nine park units sources of water quality impairments are either not listed or unknown. Addressing and alleviating water quality problems within these units will be harder since the sources are not identified. This is of particular concern at CACO, where no sources were identified by the EPA or State of Massachusetts as contributing to the 305(b) and 303(d) listed impairments that are present within the park. However, many issues pertaining to water quality were documented in Natural Resource Management Plans (refer to Wetland and Water Quality Issues section in this Chapter), so at least some water quality impairment sources have been noted by individual park units.

Four park units each had sources of impairments listed as non-point sources (ASIS, CACO, COLO, GEWA), urban and storm runoff (BOHA, FIIS, GATE, and SAHI), and waste water (ASIS, BOHA, GATE, GEWA). Combined sewer overflow (ACAD, BOHA, GATE), natural sources (ASIS, COLO, and GEWA), and point sources (ASIS, BOHA, GEWA) were listed as sources for three units each. Contaminated sediments

were listed as an impairment source for 2 units (COLO, GATE). The remainder of the known sources: agriculture (FIIS), atmospheric deposition (ACAD), eutrophication (GEWA) were each sources for one park unit.

GEWA had the highest number (5) of known sources for impairments (eutrophication, natural sources, point and non-point sources, waste water). GATE and BOHA each had 4 known sources (BOHA: Combined sewer overflow, point sources, urban and storm runoff, and waste water; GATE: contaminated sediments, combined sewer overflow, urban and storm runoff, and waste water treatment). For these three units, the sources of impairments appear to be related to the proximity of the parks to large urban, metropolitan areas (Boston and New York City). However, unknown and unlisted sources also contributed to water quality impairment at these park units. ASIS also had 4 listed sources of impairments (natural sources, point and non-point sources, and waste water treatment). COLO had 3 documents sources of impairments (contaminated sediment, natural and non-point sources) as well as unknown or not listed sources. At ACAD, atmospheric deposition, combined sewer overflow, and unknown sources all contributed to water quality impairments. Two sources (agriculture and urban and storm runoff) were identified at FIIS. Both CACO and SAHI were documented as having one known source each (CACO: non-point; SAHI: urban and storm runoff) with CACO having unknown sources listed as well (Table 13-2).

### Wetland and Water Quality Issues

A summary of primary wetland and water quality issues are presented in Table 13-3. Please note that this table is not meant to be an exhaustive list of issues within each park, but presents those issues that were identified as primary concerns by Natural Resource Management Plans and other documents.

The most common water quality issues listed by NCBN parks were point and non-point source pollution, listed as concerns at 8 parks (ACAD, ASIS, BOHA, CACO, COLO, FIIS, GATE, SAHI) (Table 13-3). Bacteria and or pathogens, waste water, and watershed development were each listed as concerns at 7 parks. Bacteria and or pathogens are concerns at ACAD, ASIS, CACO, FIIS, GATE, GEWA, and SAHI; waste water is a concern at ACAD, ASIS, BOHA, CACO, COLO, FIIS, and GATE; where as watershed development is of concern at ACAD, ASIS, CACO, COLO, FIIS, GATE, and GEWA. Eutrophication/nutrients and fisheries are similar concerns at 6 units (ACAD, ASIS, BOHA, CACO, FIIS, GATE). Agriculture, contaminants, and runoff were listed as issues at 5 units (agriculture: ASIS, CACO, FIIS, GATE, GEWA; contaminants: ACAD, BOHA, CACO, GATE, SAHI; runoff: ACAD, CACO, COLO, FIIS, GATE). Adjacent land use (ACAD, ASIS, COLO, SAHI), and water supply/water level (ACAD, BOHA, CACO, and COLO) were each listed as issues by four units. Atmospheric deposition and visitor use were similar concerns at ACAD, ASIS, and CACO. Two parks listed each of the following issues as concerns: floatable debris (CACO, GATE), habitat loss (ASIS and GATE), invasive species and/or species change (ACAD and GATE), shoreline change as it is related to water quality (COLO and GEWA), and wildlife

management (e.g. fish stocking, hunting) (ACAD and CACO). Other issues of concern were algal blooms (FIIS), lack of information (BOHA), and tidal restrictions (CACO).

Parks that identified the most water quality issues were CACO (15) and ACAD (14) (Table 13-3), CACO listed agriculture, atmospheric deposition, bacteria and pathogens, contaminants, eutrophication/nutrients, fisheries, floatable debris, point and non-point source pollution, runoff, tidal restrictions, visitor use, waste water, water supply and water level, watershed development, and wildlife management as all issues relating to water quality. ACAD listed adjacent land use, atmospheric deposition, bacteria and pathogens, contaminants, eutrophication/nutrients, fisheries, invasive species and species change, point and non-point source pollution, runoff, visitor use, waste water, water supply and water level, watershed development, and wildlife management as concerns to water quality. GATE and ASIS listed 12 and 11 issues, respectively. At GATE agriculture, bacteria and pathogens, contaminants, eutrophication/nutrients, fisheries, floatable debris, habitat loss, invasive species and species change, point and non-point source pollution, runoff, waste water, and watershed development are all issues. At ASIS adjacent land use, atmospheric deposition, agriculture, bacteria and pathogens, eutrophication/nutrients, fisheries, habitat loss, point and non-point source pollution, visitor use, waste water, and watershed development are issues. FIIS listed 9 issues: agriculture, algal blooms, bacteria and pathogens, fisheries, eutrophication/nutrients, point and non-point source pollution, runoff, waste water, and watershed development are all concerns. BOHA and COLO each listed 7 issues. At BOHA, contaminants, eutrophication/nutrients, fisheries, lack of information, point and non-point source pollution, waste water and water supply and water level are issues; while at COLO adjacent land use, point and non-point source pollution, runoff, shoreline change, waste water, water supply and water level, and watershed development are issues. There are 5 issues of concern at GEWA (agriculture, bacteria and pathogens, point and non-point source pollution, shoreline change, and watershed development), and lastly at SAHI only adjacent land use, bacteria and pathogens, and contaminants were listed as concerns.

It is interesting to note discrepancies between the impairments documented by 305(b) and 303(d) Reports and those listed by Natural Resource Management Plans and other documents as issues of concern relating to water quality. For example, agriculture was listed by 303(5) and 303(d) Reports as an impairment at only one unit (FIIS), while 5 park units (ASIS, CACO, FIIS, GATE, and GEWA) identified this as a problem in their Natural Resource documents. This may be an indication that information on water quality within the Parks is not being conveyed to the State or EPA for inclusion in their 305(b) and 303(d) assessments.

#### Long-term Monitoring Parameters

A summary of water quality related parameters that have been monitored long-term at NCBN parks is shown in Table 13-4. The majority of parameters that have long-term data available have not been monitored by the National Park Service, but by other federal (USGS), state, or local (e.g. Friends of the Bay, Maryland Coastal Bays, etc.) agencies,

therefore in the following summary “programs” refers to all of the combined monitoring of wetland and water quality regardless of the agency responsible for data collection.

Currently the NCBN is developing and in the initial phases of testing long-term monitoring programs for salt marsh vegetation, estuarine nekton, and estuarine nutrients. A pilot program to test the implementation of the Salt Marsh Vegetation and Estuarine Nekton protocols was initiated in 2003. These protocols focus on data collection for vegetation and nekton (fish and decapods) species composition and abundance on salt marshes. The protocols were implemented at COLO, GATE, and FIIS in 2003; and at CACO, SAHI, and BOHA in 2004. In 2005, they will be implemented at ASIS and GEWA, and perhaps ACAD. It is hoped that continued long-term monitoring of salt marsh vegetation and nekton will take place every 3-5 years.

ASIS and CACO have the most long-term monitoring programs, with 7 long-term programs related to wetlands and water quality. ACAD and BOHA have 5 and 4 programs, respectively. Parks within the NCBN that have limited (3 or fewer) long-term monitoring programs are COLO (3 programs), GATE (3 programs), FIIS (2 programs), SAHI (2 programs) and GEWA (1 program). With the exception of GATE, where 2 programs are run by the NPS, in parks with 4 or fewer programs (BOHA, COLO, FIIS, GATE, GEWA, and SAHI) all the wetland and water quality monitoring are conducted by non-NPS entities.

Estuarine and marine water quality data are collected at 8 of the 9 parks (ACAD has no long-term estuarine/marine water quality program), however only at ASIS and GATE are these data collected by the NPS. Algal blooms are monitored at 4 parks (ASIS, COLO, FIIS, and SAHI) none of which are conducted by the NPS. Three parks (ACAD, ASIS, and CACO) have National Atmospheric Deposition Program (NADP) sites (all administered by the NPS in collaboration with the National Atmospheric Deposition Program) which monitor wet deposition, and two of these sites (ACAD and CACO) also monitor mercury deposition. In 2002 the NPS-Air Quality Division recommended establishing a permanent air quality monitoring station, located and operated under EPA standards, within COLO. The Yorktown Visitor Center was chosen for the construction of the monitoring station (Manter et al. 2002). Estuarine and marine fish are monitored at ASIS, CACO, and GATE, with the surveys conducted in conjunction with NPS staff at CACO and GATE. Submerged aquatic vegetation is monitored at ASIS and CACO, macroalgae at ASIS, and sediments at ASIS and BOHA, all by non-NPS agencies. Freshwater water quality is monitored at ACAD and CACO (by NPS staff) and wetland/salt marsh vegetation are monitored by CACO and GATE. At GATE trends in wetland status are compiled by the State of New York. Estuarine and marine benthic communities are monitored at BOHA and COLO, by non-NPS agencies, while freshwater benthic community structure is monitored at ACAD by the NPS. Fish and shellfish pathology are monitored at BOHA by the State of Massachusetts. Finally, freshwater levels are monitored at ACAD by the USGS.

### Suggestions for Research, Monitoring, and Inventory Needs

This section provides suggestions for research, long-term monitoring and inventory needs for each park unit discussed in this report. These suggestions are based upon a review of the existing wetland and water quality issues and the current monitoring programs as summarized in this report. This is not meant to be an exhaustive list, however, it is hoped that it may provide some guidance to the Natural Resource Managers of each park unit. Thomas Stone National Historic Site is not listed because there are no water resources within the park.

#### *Acadia National Park*

- Estuarine and marine water quality monitoring.
- Monitoring estuarine wetland communities (Bass Harbor Marsh, Northeast Creek).
- Water quality data to determine attainment status for 305(b) and 303(d) purposes. Many of the waters (estuarine and fresh) have insufficient data to determine attainment status (refer to Table 3-1).

#### *Assateague Island National Seashore*

- Monitoring salt marsh communities (one of largest communities of the park). The pending implementation (summer 2005) of the Salt Marsh Vegetation and Estuarine Nekton Protocols will provide long-term data on this ecosystem.
- Monitoring and inventory of fresh and brackish water resources of the park's interior.

#### *Boston Harbor Islands National Park Area*

- Since BOHA is a relatively new park, one of primary concerns is a lack of baseline information on intertidal, subtidal, wetland resources, and coastal erosion.
- Water quality monitoring for public health and recreation. Current water quality monitoring conducted by the Massachusetts Water Resources Authority is primarily located only around outfall areas (Boston Harbor and Massachusetts Bay).
- Monitoring salt marsh communities. The implementation (summer 2004) of the Salt Marsh Vegetation and Estuarine Nekton Protocols will provide long-term data on this ecosystem.

#### *Cape Cod National Seashore*

- Water quality data of freshwater ponds for 305(b) and 303(d) purposes. Only Ryder Pond has been assessed for 305(b) and 303(d) purposes as listed by the EPA and/or State of Massachusetts.

#### *Colonial National Historical Park*

- Monitoring and inventory of the Coastal Plain Depression Ponds. These ponds are a rare and threatened seasonal wetlands community. Ponds outside of COLO

have been surveyed (Rawinski 1997), yet it appears that very little monitoring of this resource within the park has been conducted.

- Monitoring the salt marsh communities. The implementation (summer 2003) of the Salt Marsh Vegetation and Estuarine Nekton Protocols will provide long-term data on this ecosystem.

*Fire Island National Seashore*

- Monitoring the salt marsh communities. The implementation (summer 2003) of the Salt Marsh Vegetation and Estuarine Nekton Protocols will provide long-term data on this ecosystem.

*Gateway National Recreation Area*

- Monitoring and/or inventory of fisheries to document loss and/or decline. The Jamaica Bay survey has provided intermittent information, but more consistent monitoring would be useful to document changes in fisheries.
- Monitoring freshwater resources on a consistent basis.

*George Washington Birthplace National Monument*

- Monitoring salt marsh communities (Pope's Creek, Dancing Marsh). The pending implementation (summer 2005) of the Salt Marsh Vegetation and Estuarine Nekton Protocols will provide long-term data on this ecosystem.

*Sagamore Hill National Historic Site*

- Monitoring the salt marsh adjacent to Cold Spring Harbor. The implementation (summer 2004) of the Salt Marsh Vegetation and Estuarine Nekton Protocols will provide long-term data on this ecosystem.
- Monitoring freshwater resources on a consistent basis.

Table 13-1. Summary of water quality impairments, compiled from 305(b) and 303(d) Reports, within the Northeast Coastal and Barrier Network. THST is not listed because there are no wetlands or waterbodies within this unit.

Water Impairment	Park									Total Parks with Impairment
	ACAD	ASIS	BOHA	CACO	COLO	FIIS	GATE	GEWA	SAHI	
Acidity				X						1
Benthic standard					X					1
Dissolved oxygen		X		X	X		X	X		5
Fish consumption advisory	X		X	X	X		X	X	X	7
Nutrients		X		X	X		X	X		5
Organic enrichment		X		X	X		X	X		5
Pathogens (bacteria/fecal coliform)	X	X	X	X	X	X	X	X	X	9
PCBs	X				X		X	X	X	5
Sedimentation					X					1
Shellfishing restriction	X	X	X	X	X	X	X	X	X	9
Suspended solids			X							1
Toxics/metals	X		X	X			X			4
Trash/debris			X							1
Turbidity/suspended sediment			X					X		2
<i>Total Number of Impairments per Park</i>	5	5	7	8	9	2	8	8	4	

Table 13-2. Summary of sources for water quality impairments, compiled from 305(b) and 303(d) Reports, within the Northeast Coastal and Barrier Network. THST is not listed because there are no wetlands or waterbodies within this unit.

Source of Impairments	Park									Total Parks with Impairment Source
	ACAD	ASIS	BOHA	CACO	COLO	FIIS	GATE	GEWA	SAHI	
Agriculture						X				1
Atmospheric Deposition	X									1
Contaminated Sediment					X		X			2
Combined Sewer Overflow	X		X				X			3
Eutrophication								X		1
Natural Sources		X			X			X		3
None Listed or Unknown	X		X	X	X		X	X		6
Non-Point Sources		X		X	X			X		4
Point Sources		X	X					X		3
Urban Storm Runoff			X			X	X		X	4
Waste Water		X	X				X	X		4
<i>Total Number of Known Sources per Park</i>	3	4	5	2	4	2	5	6	1	

Table 13-3. Summary of primary wetland and water quality issues (as identified by Natural Resource Management and other documents) within the Northeast Coastal and Barrier Network. THST is not listed because there are no wetlands or waterbodies within this unit. Information sources listed in footnotes.

Wetland & Water Quality Issues	Park									Total Parks with issue
	ACAD <sup>1</sup>	ASIS <sup>2</sup>	BOHA <sup>3</sup>	CACO <sup>4</sup>	COLO <sup>5</sup>	FIIS <sup>6</sup>	GATE <sup>7</sup>	GEWA <sup>8</sup>	SAHI <sup>9</sup>	
Adjacent Land Use	X	X			X				X	4
Agriculture		X		X		X	X	X		5
Algal Blooms						X				1
Atmospheric Deposition	X	X		X						3
Bacteria/Pathogens	X	X		X		X	X	X	X	7
Contaminants (e.g., PCB's)	X		X	X			X		X	5
Eutrophication/Nutrients	X	X	X	X		X	X			6
Fisheries	X	X	X	X		X	X			6
Floatable Debris				X			X			2
Habitat Loss		X					X			2
Invasives/Species Change	X						X			2
Lack of Information			X							1
Point & Non-Point Source Pollution	X	X	X	X	X	X	X	X		8
Runoff (surface/stormwater)	X			X	X	X	X			5
Shoreline Change					X			X		2
Tidal Restrictions				X						1
Visitor Use	X	X		X						3
Waste Water	X	X	X	X	X	X	X			7
Water Supply/Water Level	X		X	X	X					4
Watershed Development	X	X		X	X	X	X	X		7
Wildlife Management	X			X						2
<i>Total Number of Issues per Park</i>	14	11	7	15	7	9	12	5	3	

1. Kahl et al. 2000; ME-DEP 1998; NPS 2000;
2. NPS 1991a; MCBP 1999
3. Flora 2002
4. Godfrey et al. 1999; Cape Cod Commission, 1998; NPS 1998; PBRMA 2003; Portnoy et al. 2001
5. NPS 1994
6. SSER date unknown; Kopp et al. 2002; Suffolk County Government website
7. NPS 1999; NPS 2001; NY-DEC 2002; NY-NJ HEP 1995
8. Kopp et al. 2002; USGS 2000
9. Friends of the Bay website; Kopp et al. 20002

Table 13-4. Summary of wetlands and water quality related parameters that have been monitored long-term within or adjacent to Northeast Coastal and Barrier Network parks. Some parameters may be monitored by non-NPS agencies. THST is not listed because there are no wetlands or waterbodies within this unit. \* denotes parameter is monitored by NPS.

Water Quality Parameters	Park									Total Parks Monitoring
	ACAD	ASIS	BOHA	CACO	COLO	FIIS	GATE	GEWA	SAHI	
Algal Blooms		X			X	X			X	4
Atmospheric Deposition (mercury)	X*			X*						2
Atmospheric Deposition (wet)	X*	X*		X*						3
Benthic Community (estuarine/marine)			X		X					2
Benthic Community (freshwater)	X*									1
Fish & Shellfish Pathology			X							1
Fish (estuarine/marine)		X		X*			X*			3
Macroalgae		X								1
Sediments		X	X							2
Submerged Aquatic Vegetation		X		X						2
Water Level (freshwater)	X									1
Water Quality (estuarine/marine)		X*	X	X	X	X	X*	X	X	8
Water Quality (freshwater)	X*			X*						2
Wetland Area/Salt Marsh Vegetation				X*			X			2
<i>Total Number of Parameters per Park</i>	5	7	4	7	3	2	3	1	2	

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## Appendix. I: List of acronyms used throughout document.

<b>Acronym</b>	<b>Definition</b>
ACAD	Acadia National Park
ACBCMP	Alliance for Chesapeake Bay Citizen's Monitoring Program
ACEC	Areas of Critical Environmental Concern
AIRMoN	Atmospheric Integrated Research Monitoring Network
APVA	Association for the Preservation of Virginia Antiquities
ASIS	Assateague Island National Seashore
BOHA	Boston Harbor Island National Park Area
CACO	Cape Cod National Seashore
CBNERR-VA	Chesapeake National Estuarine Research Reserve
CCB	Cape Cod Bay
CNWR	Chincoteague National Wildlife Refuge
Coastal 2000	National Coastal Assessment
COLO	Colonial National Historic Site
CSO	combined sewer overflows
CWAPTW	Clean Water Action Plan Technical Workgroup
DCR-DNH	Virginia Department of Conservation and Recreation's Division of Natural Heritage
DITP	Deer Island Treatment Plant
DRINKS	Drinking Water Supplies database
EMAP	Environmental Monitoring and Assessment
EPA	Environmental Protection Agency
FIIS	Fire Island National Seashore
GAGES	Stream Gages database
GATE	Gateway National Recreation Area
GEWA	George Washington's Birthplace National Monument
GIS	Geographic Information System
HUC	Hydrologic Unit Codes
IDEA	Inventory Data Evaluation and Analysis
IEC	Interstate Environmental Commission
IFD	Industrial Facilities Discharge database
LUC	Land Use Codes
MA-CZM	Massachusetts Office of Coastal Zone Management
MA-DEM	Massachusetts Department of Environmental Management
MA-DEP	Massachusetts Department of Environmental Protection
MA-DPH	Massachusetts Department of Public Health
MAIA	Mid-Atlantic Integrated Assessment
MCBP	Maryland Coastal Bays Program
MDE	Maryland Department of the Environment
MD-DNR	Maryland Department of Natural Resources
MDN	Mercury Deposition Network
ME-DEP	Maine Department of Environmental Protection
MWRA	Massachusetts Water Resource Authority
NADP	National Atmospheric Deposition Program

<b>Acronym</b>	<b>Definition</b>
NCBN	Northeast Coastal and Barrier Network
NEP	National Estuary Program
NJ-DEP	New Jersey Department of Environmental Protection
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NPS	National Park Service
NWI	National Wetlands Inventory
NWIS	National Water Information System
NYC-DEP	New York City Department of Environmental Protection
NY-NJ HEP	New York-New Jersey Harbor Estuary Program
NYS-DEC	New York State Department of Environmental Conservation.
ONWR	Outstanding National Resource Waters
ORW	Outstanding Resource Waters
PBRMA	Pleasant Bay Resource Management Alliance
PCB	Polychlorinated Biphenyls
PRIMENet	Park Research and Intensive Monitoring of Ecosystems Network
QAPP	Quality Assurance Project Plan
REMAP	Regional Environmental Monitoring and Assessment Program
RF3	River Reach File database
RIBS	Rotating Intensive Basin Studies
SAHI	Sagamore Hill National Historic Site
SAV	Submerged aquatic vegetation
SeaWiFS	Sea-viewing Wide Field-of-view Sensor
SET	surface elevation tables
SMAST	School for Marine Science and Technology
SSER	South Shore Estuary Reserve
STORET	Storage and Retrieval database management system
SWQS	Surface Water Quality Standards
THST	Thomas Stone National Historic Site.
TMDL	Total Maximum Daily Load
TSHT	Thomas Stone National Historic Site
USGS	United States Geological Survey
VA-DEQ	Virginia Department of Environmental Quality
VDH	Virginia Department of Health
VIMS	Virginia Institute of Marine Science
WI/PWL	Waterbody Inventory/Priority Waterbodies List
WRA	Water Resources Administration
WRD	Water Resource Division